This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

**Usage guidelines**

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

**About Google Book Search**

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

NYPL RESEARCH LIBRARIES
3 3433 06636564 8

3 - VII

Buet

4.26-01

With the Publishers Complime

# ENGINEERING ESTIMATES

AND

# COST ACCOUNTS,

BY

## FRANCIS G. BURTON, A.S.A.A.,

*Formerly Secretary and General Manager of the Milford Haven Shipbuilding and Engineering Company Limited.*

SECOND EDITION.

PRICE THREE SHILLINGS NET.

1900
THE TECHNICAL PUBLISHING COMPANY LIMITED,
31, WHITWORTH STREET,
MANCHESTER.

THE NEW YORK
PUBLIC LIBRARY
474788

ASTOR, LENOX AND
TILDEN FOUNDATIONS.
1909

TO

SIR EDWARD JAMES REED, K.C.B., M.P.,

KNIGHT OF THE IMPERIAL ORDERS OF ST. STANILAUS OF RUSSIA,
FRANCIS JOSEPH OF AUSTRIA,
MEDJIDIÉ OF TURKEY, AND RISING SUN OF JAPAN;
FELLOW OF THE ROYAL SOCIETY,
VICE PRESIDENT OF THE INSTITUTION OF NAVAL ARCHITECTS,
MEMBER OF COUNCIL OF THE INSTITUTION OF
CIVIL ENGINEERS,
MEMBER OF THE INSTITUTION OF MECHANICAL ENGINEERS,
ETC., ETC., ETC.,

IN REMEMBRANCE

OF

HIS KINDNESS AND CONSIDERATION IN YEARS LONG PAST,

AND IN

UNDIMINISHED ADMIRATION FOR HIS GENIUS,

THIS TREATISE IS, WITH HIS PERMISSION,

RESPECTFULLY DEDICATED

BY

THE AUTHOR.

# Preface to First Edition.

THE subject matter of the second portion of this treatise, that on cost accounts, appeared in *Engineering*, Vol. LVII., during January and February, 1894. Although these chapters have been entirely re-written, the procedure they suggest has not been altered, nor have the examples been materially varied. I am under considerable obligation to Mr. W. H. Maw, one of the joint editors, for the permission so courteously given to again use the forms of account which had appeared in my articles in *Engineering.*

The difficulties I have endeavoured to grapple with, in both estimates and cost accounts, are such as I have met in actual practice, and such as must frequently present themselves to the staff of an engineering establishment. I cannot too strongly express my conviction that no method of estimating or costing will be satisfactory, unless the cost clerk possesses the most intimate knowledge of the business, and is sufficiently skilful and independent in practice to vary his forms of account to the difficulties which may from time to time arise. Uniformity of principle must certainly be maintained, but this does not justify pettifogging uniformity of detail.

I have expressed the opinion that public accountants and auditors, practising their profession, cannot efficiently deal with engineering cost accounts, the value of which to the engineer will depend on an infinite number of details, constantly changing. I have given my reasons for this opinion, and believe the more eminent and intelligent members of the accountancy profession will agree with it. It is chiefly the younger members thereof, the "Examination Wallahs," whose knowledge of business is limited to the making of artistic ticks and the checking of additions, who will take umbrage thereat.

I have been placed under considerable obligation for the loan of estimates and specifications by so many engineers that it would be invidious to name any of them—they are in this only following the traditions of a profession which has helped to place our country first in the race of progress. But I must not fail to acknowledge the kindness of three members of the Institute of Chartered Accountants—Mr. George Williamson, Mr. Thomas Pilling, and Mr. Alfred Shuttleworth, all of Manchester—who have not only assisted me in procuring information, but who have also encouraged me by that kindly sympathy so much needed by the embryo-author.

FRANCIS G. BURTON.

## Preface to Second Edition.

THE alterations made in this second edition are few, as my experience since the publication of the first edition has not led me to alter the method of accounts recommended. A chapter has been added on "Cost Accounts for small works," in which the accounts are slightly modified in order to save the expense of clerical labour, when such expense is of importance. The suggestion is, however, only made for very small establishments.

F. G. B.

POYNTON, *November*, 1900.

# TABLE OF CONTENTS.

## ENGINEERING ESTIMATES.

CHAPTER I.—BOILERS. PAGE.

Competition and Estimating—Division into "Materials" and "Wages"—Ascertainment of Quantities—Prices of Materials, and Variation in Markets—Form of Estimate for Boiler—Details of same—Establishment Charges ........ 1

CHAPTER II.—GAS AND OTHER ENGINES.

Form of Estimate for Gas Engine—Details of same—Necessity of Estimates for Standard Types of Machines—Form of Estimate for Steam Engine—Necessity of Detail to Compare with Cost Accounts........ 15

CHAPTER III.—STEAMSHIPS.

Form of Estimate for Steamships—Details of same—Various kinds of Specifications—Form of Estimate for Marine Engine........ 29

CHAPTER IV.—CATALOGUE MACHINERY AND FOREIGN ESTIMATES.

Model Estimates for Catalogue Machinery—Form of Estimate for Lathe—Variation of Establishment Charges when yard short of work—Foreign Tenders—Form of Foreign Estimate for Sugar Plant—Need for Assistance of Commercial Experts ........ 45

## ENGINEERING COST ACCOUNTS.

CHAPTER V.—COST ACCOUNTS.

Necessity for detailed Cost Accounts—Advantage thereof in Preparation of Estimates—Agreement of Cost Accounts with Financial Books—Invoice Book—Stores Issue Book—Wage Book ........ 55

CHAPTER VI.—DIVISION OF COST ACCOUNTS.

Threefold Division of Accounts—Amended form of Invoice Book ........ 65

CHAPTER VII.—DEPARTMENT ACCOUNTS.

Form of "A" or Departmental Account—Details of same—Summary of Interest and Depreciation—Ordinary Method of Calculating Depreciation 71

CHAPTER VIII.—DEPRECIATION, LOOSE TOOLS, &c. PAGE.

Correct Basis for Calculation of Depreciation—Inventory of Buildings and Plant — Increased Rate of Depreciation through Inventions — Loose Tools—Estimated Charges—Transfers of Departmental Accounts to "B" and "C" Sheets ........ 84

CHAPTER IX.—"B" AND "C" COST ACCOUNTS.

Goods made in Factory *en bloc*—General Expenses -"B" Sheets for Sectional portion of Machine or Contract—Form of "C" Sheets for Completed Machine or Contract—Form of Approximate Monthly Profit and Loss Account ........ 94

CHAPTER X.—COST ACCOUNTS FOR SMALL WORKS.......... 106

CHAPTER XI.—FOREIGN CONTRACTS.

Difficulties arising under Foreign Laws and Customs—Form of Approximate Monthly Profit and Loss Account—Details thereof—Information afforded to Partners—Cost of Procuring Orders and Contracts—Preliminary Surveys and Expenses—Trade Debits and Credits, or Departmental Profit and Loss Accounts........ 112

CHAPTER XII.—RESERVE FUNDS.

Threefold Character of Reserve Funds: (1) Equalisation of Dividends; (2) Depreciation of Buildings; (3) Replacement of Machinery—Method of Accumulation—Principles of Investment—Conclusion ........ 126

# ENGINEERING ESTIMATES.

## CHAPTER I.

### BOILERS.

THE increasing keenness of competition in the engineering trades, not only amongst English mechanical engineers, but as between them and foreign rivals, renders the proper compiling of estimates of cost, on which to base tenders, of very great importance. This importance and the difficulty of accomplishing the task are increased by the varied conditions and equipment of different manufactories, by the relation which establishment charges bear at any given period to the actual constructive charges, and by considerations of policy which determine the minimum amount of work which, at any absence of profit, must be obtained for the factory. A very brief consideration will serve to show that these complicated problems require something more than "rule-of-thumb" assumptions or arbitrary percentages to solve them, and that there is no golden rule by which accurate and reliable estimates can be obtained without careful detail work.

Well-organised engineering firms in the present day keep elaborate accounts of the cost of all work they perform, and these, when framed on a correct basis and carefully worked out, form the most reliable data for future tenders; indeed, one of the principal services to which they can be applied is this of future estimating. Unfortunately, however, many principals guard these cost sheets most jealously from their managers, foremen, and draughtsmen, on account of the vivid insight they give into the business. Whether it would not be wiser to treat the executive officers with greater confidence, and place before them in graphic form the results of their good or ill management, is a question we must leave employers to decide for themselves; but when they determine to ask their officers to estimate without access to the results of previous estimates, they should, at least, check the new calculations by the ascertained figures for previous work. There are, however, some general principles and some means of obtaining data, which will be serviceable to engineers and managers who have not opportunity of obtaining completed and reliable cost accounts, and these principles may usefully be summarised. Of course, our readers will understand that we do not refer to standard types of machines, such as are described and priced in the catalogues of firms. The convenience of fixed prices for such articles as can be manufactured and delivered from stock, or can be proceeded with in anticipation of orders, is so great commercially as to outweigh any advantage to be obtained by individual estimating and tendering. These prices must indeed be from time to time revised, but the revision should be based on an average of actually obtained costs of manufacture, combined with considerations of the course of the market and competition, rather than on those vague and unsatisfactory anticipations which we are frequently compelled to adopt in more general estimates.

In order to ensure approximate accuracy, it is desirable that the estimates should be divided into two parts—the first including "materials and expenses," the second only "salaries and wages." It is essential that the various items should adhere closely to the expected expenditure, without any allowances for profit on materials and expenses, or any increase of rate of wages beyond that paid in the yard. A profit certainly ought to be made on both materials and wages, but this profit should be stated as a separate item, so that the extent of it may be seen, and its variation determined upon after due allowance for such commercial considerations as lie outside the proper business of estimating. The art of the engineering draughtsman has now become so perfect, that there is little difficulty in ascertaining (in weight, number, or measurement) the quantities of materials in any machine, combination, or erection, and the first step to be taken is, whenever possible, to lay off the proposed work in such manner that these quantities can be arrived at. Particular care should be taken, when the tender is for a larger size of machine or boiler, but of a similar type to one already made in the works, that no error is made in the added quantity of material, if that of the old machine is taken as the base. We have seen serious errors arise through increased length being added, without any allowance of increased circumference, and this omission is more likely to occur in the hasty preparation of a tender than our readers will readily imagine. To make our observations more definite, we give below a skeleton form of estimate for an ordinary Lancashire boiler.

The weight and quantity of material having been ascertained by the draughtsman, the first difficulty which meets the estimator is the determination of the price at which these materials are to be charged in the estimate. It has been already said that no profit should be made in the body of the estimate, on either materials or wages; the iron, &c., must, therefore, be charged at the price it will actually cost to purchase. It is just possible that the estimating firm may at the time have in its stores plates and angles which have cost £2 per ton more than current market prices; but as competing firms will probably not be hampered with any such stocks, the former purchase price cannot now be taken as a basis, but only the present market price, the difference between the two being part of the general loss of the firm. The same basis of actual market price must also apply in the less frequent contingency of plates and angles being in stock, which have been purchased at less than current prices. There is, however, an exception to this rule, to

## ESTIMATE FOR BOILER FOR THE GOLD EXTRACTION CO. LIMITED, 30 FT. LONG, TO BE 7 FT. DIAMETER, WITH 2 INTERNAL FLUES 2 FT. 9 IN. INTERNAL DIAMETER.

| | Weight or quantity. | Price. | Material. | Salaries and wages. |
|---|---|---|---|---|
| DRAWINGS. | | | | |
| BOILER SHELL. | | | | |
| Bending .................... | | | | |
| Drilling .................... | | | | |
| Erecting .................... | | | | |
| Riveting .................... | | | | |
| FLUE TUBES. | | | | |
| Bending .................... | | | | |
| Drilling .................... | | | | |
| Riveting .................... | | | | |
| Galloway tubes .............. | | | | |
| ENDS AND STAYS. | | | | |
| ANGLE IRON. | | | | |
| MOUNTINGS AND FITTINGS. | | | | |
| Steam receiver .............. | | | | |
| Manholes .................... | | | | |
| Branches .................... | | | | |
| Safety valves ............... | | | | |
| Water gates ................. | | | | |
| Pressure gate ............... | | | | |
| Stock valve ................. | | | | |
| Feed valve and pipe ......... | | | | |
| Blow-off pipe and tap ....... | | | | |
| Fusible plugs ............... | | | | |
| Grate { Bars ............... | | | | |
| Grate { Doors .............. | | | | |
| Frames ...................... | | | | |
| Footplates .................. | | | | |
| Dampers, &c. ................ | | | | |
| SUNDRY STORES, including blocks | | | | |
| LESS scrap iron ............... | | | | |
| ADD cost of materials .......................................... | | | | |
| TOTAL ESTIMATED NET COST ...................... | | | | |
| ADD— | | | | |
| Use of machinery and tools .................................. | | | | |
| Management charges, including superintendence, rent, insurance, gas, water, &c. ........................... | | | | |
| TOTAL ESTIMATED GROSS COST .................. | | | | |
| *ADD FOR PROFIT* .............................................. | | | | |
| *TENDER* .................................... £ | | | | |

which at times it is of the most serious importance to give effect. Every market is permanently in a state of "unstable equilibrium," but the instability at certain epochs becomes more marked, and assumes a line of rise or fall in prices, extending continuously over a period of some months. In such epochs the estimator must carefully consider the progress of market fluctuations, the cause thereof, and the probable result at the time he will require to purchase (or, if in stock, to use) his materials; and the price he thus arrives at will be the one he must insert in his estimate. If he neglects this exception, he will, in the case of a rising market, suffer a loss he might have guarded himself against, and in the case of a falling market will unduly increase his price above other firms by neglecting a factor which they have taken into account. To some extent the same exception applies to the item of wages. But wages are more difficult to deal with and anticipate than materials, since the modern practice of trade unions is not guided so much by fixed principles or general considerations, as by the opportune advantages to be obtained from the exigencies of the employers.

The first item which we have placed on our skeleton estimate is drawings. It has now become a common practice for firms to send out fully detailed specifications for boilers, which specifications, in many cases, are compiled by one or other of the large boiler insurance companies. In such cases the insurance companies carefully provide for their own requirements by specifying that two complete tracings, with figured dimensions showing the boiler as it will actually be made, shall be supplied, together with particulars in detail of the riveting; one of these tracings being for their own use, and the other for the purchaser. Very frequently these have to be submitted for the approval of the engineer of the insurance company, or other consulting engineer, before the work is put in hand. Thus it will be seen that before the work of the mechanics can be commenced, the draughtsman *must to a large* extent have prepared detail drawings, and taken therefrom two tracings for approval by the purchaser. In the case of a boiler, or one of the less complex machines, the cost of this work can readily be estimated from the time occupied on previous work of the same class. But in the case of large engines, or machinery in a transition and progressive state, additional time will probably be occupied in the drawing office in improvements and developments. In such cases the estimator should freely consult with the chief draughtsman with regard to his time; indeed, we cannot too strongly insist that the freest and most genial conference between the principal officers of a firm is of the utmost importance to its success, and that the manager who most courteously and freely consults with his assistants, and encourages them to be candid in their suggestions, will have an enormous advantage over the chief who limits his intercourse with his subordinates to his instructions to them.

When we come to the boiler shell, it is necessary to remember that the brand of the plates has to be stated in the tender, and that the material, as well as the workmanship, is to be of the best quality. It is usual to specify that there shall be inspections during construction, as well as a final one on completion of the work; namely, first, when the plates are ready for rolling; secondly, when the boiler is plated, and the riveting of the shell and flues has begun; and, finally, on its completion. The plates are to be capable of standing a test for tensile strength, and bending tests, both hot and cold, and their dimensions are usually fixed by the number of rings specified in the boiler, with the limitation of number of plates permitted in each ring. The plates for the flues are usually specified to be of the best Yorkshire Snedshill, or best best Staffordshire iron, or other iron of equal quality; although in some cases Low Moor, Bowling, or Farnley plates are specifically stipulated, either for the whole or a portion of the flues. It will be readily seen that there is sufficient variation in the prices of these various qualities of iron to make the quality required of considerable moment in the tender. The end plates are usually specified of a particular quality of iron, and the gusset stays and angle irons specified in position. Care must therefore be taken that these end plates are calculated at the proper price.

Consulting engineers, and more particularly the boiler insurance companies, are becoming more stringent in their regulations for the riveting of boilers. It is now generally specified that the rivet holes, both in shell and flues, shall be drilled out of the solid plate, and, when practicable, that this shall be done with the plates and angles in position; and that should the holes be at all unfair, they should be rimered perfectly true before riveting. The quality of the rivets is also specified as of Low Moor, Bowling, or Farnley iron, or other of equal quality, and that whenever practicable the riveting is to be done by machinery. It will be evident to our readers that these points in the estimate require careful consideration when inserting the figures in the body of the form. This will more particularly apply to managers and other officers who are accustomed to a less expensive and carefully prepared class of work than boiler work, such as, for instance, roof and bridge work. It is not, of course, usual for a firm engaged solely on roof or bridge work to suddenly undertake the construction of Lancashire boilers; but it is possible for a sub-manager in such a firm to accept an opening in a boiler shop, and whilst his mind is for the time in a transition state he must be careful to remember such points of interest as are here indicated.

The boiler will, when finished, and with all the mountings in position, except the safety valve, be submitted to hydraulic test, and the cost of this test must be included under one of the sub-headings of boiler shell, say erecting.

Galloway tubes and mountings will usually be purchased by the boiler-maker from manufacturers of such articles, and the charge must be the actual market price at which they can be purchased, wages being inserted at the expected actual cost of fixing them into the boiler.

Hitherto we have been dealing chiefly with the first money column of the estimate; we have now to consider the second, which covers salaries and wages; and it is here that former cost accounts will prove of great assistance if they can be referred to. The experience of most managers and foremen will enable them to determine, approximately, the amount of labour required for any given quantity of work; indeed, the ability to determine this is a foundation for our system of piece work. But the productive value of labour varies in different shops, both by reason of difference of equipment, and the training of the men in different localities. In a large contract, or in several large contracts, these advantages of the one workshop over the other will enable the proprietor of the better-equipped shop to accept a lower price or to obtain a larger profit. But as few workshops in the present day can retain their hold on the market without being more or less progressive, or without adapting their methods and discipline to the improvements which are being made generally throughout the trade, it is well for the foreman to record his experience of the amount of labour expended on any given quantity of work which from time to time passes under his notice. This experience should be reduced to the form of tables, in which will be expressed the nature of the work, the weight of materials, and the labour expended on such material. The labour should be stated in days or hours, and not in terms of money, so that it will not be rendered useless by variations in the rates of wages. A summary of this kind, which may be kept by most foremen in a notebook, will prove of material service to them in many after periods of their career.

It will be observed that the second column is headed "Salaries and wages." It is not intended that the salaries of the partners or manager, or foremen, clerks, storekeepers, timekeepers, &c., should be located to the different contracts upon which they are expected to be engaged. This charge is provided for in a subsequent part of the estimate. *Generally, however*, it will be convenient to place the construction of a boiler in the charge of a sub-foreman or leading man, and the wages of this man will be more conveniently stated under the heading of "Wages" in the body of the estimate against the several items, than as part of the management charges.

At the end an item is inserted for "Sundry stores, including blocks." It is needful to exercise great care not to duplicate weight. Thus, if rivets are included by the draughtsman in the weight of the boiler shell, &c. (as is sometimes, though improperly, done), the cost of them must not again be estimated under "Sundry stores." Again, the words "including blocks," are intended to cover only such blocks as may be expected to be destroyed in the course of construction; the use of others, which at the end of the period will be returned into stores, is provided for under the head of "Use of machinery and tools." From the estimated cost of materials must be deducted the scrap iron which may be expected to arise, the price being taken at the market value, under the same conditions as are applied to materials. These anticipated variations do not, of course, affect the estimate for scrap so materially as they do plates, angles, and rivets, because both weight and price bear only a very small proportion to the total cost of work. The balance after this deduction represents the net cost of materials, which must be carried into the second column, the total of which, after making such addition, will give the estimated cost of the contract in *direct* wages and materials.

It will be seen, on reference to our model form, that we have now two additions to make, on the due appreciation of which depends most frequently the profit or loss of the firm, and the success of its competition with other workers. The manager or foreman who has not access to the cost sheets and private accounts of the firm cannot, of his own knowledge, determine the percentage which should be added for establishment charges, and he must be content to accept the ratio given him by his employer, or which has previously been in use. We may, however, indicate the principles on which this charge should be calculated, and a knowledge of these principles may enable our readers to detect and point out any flagrant blunders.

Whatever percentage is adopted, it should be calculated only on the wages estimated, and not on the total of wages and materials. The reason for this is not quite so obvious in the case of a simple boiler as it is when considered with reference to more complex constructions, such as a large engine, or a steamship. In the case of a steamer, for instance, the quantity and description of stores purchased, or estimated to be purchased, will vary considerably, not only as between different yards, but also in the same yard at different periods. In one ship the davits may have been forged, finished, and fixed by the firm's own hands within the shipyard; in a second ship, stress of work, or larger davits, may compel recourse to another forge, leaving the adjustment and fitting in place to be done within the yard. But as in the latter case the machinery and tools of the building yard would not be used for the actual forging, it would be unjust to add to the estimated purchase price any amount for user of plant which will not be employed. The most constant and equitable basis over which to distribute the whole of those items termed "establishment charges" appears, therefore, to be the wages within the yard.

The charge for use of machinery and tools throughout the yard should be the sum of three items, such items being, of course, the proportion for the six months only :—

1. The interest of the capital expenditure for such tools and machinery, such expenditure to be taken at the balance appearing in capital account, after writing off depreciation to date.

2. The amount required to write down the value of such tools and machinery by means of depreciation account, so that at the end of their several lives they may have been reduced to the value of scrap iron.

3. The amount required for current repairs (not being renewals or equivalent to renewals) required to keep the tools, &c., in such working order as will prolong their lives to their longest natural period.

This sum, having been ascertained, must be divided over the work in the yard, or expected in the yard, in the proportion of the wages for the various contracts. Thus—

| | |
|---|---|
| There are contracts running the wages on which during the ensuing six months will amount to | £7,800 |
| Tenders are made, and anticipated to be accepted, the wages on which for the same period will amount to | 2,080 |
| | £9,880 |

| | |
|---|---|
| The interest on the present capital charge for tools and machinery for six months is | £300 |
| The depreciation for the same period | 150 |
| The repairs for the six months | 53 |
| | £503 |

The amount for use of machinery and tools to be added to any of the tenders will be 5·09 per cent of the wages estimated.

The remainder of the management charges, such as salaries of partners or directors, of managers, general foremen, storekeepers, timekeepers, draughtsmen, and clerks, and rent, rates, insurance, coal, gas, and water, should, in like manner, be ascertained for the six months, and divided over the same figure of wages.

It must be remembered that these charges are only estimates, and will vary greatly in different establishments, so that whenever it is possible they should be checked at frequent intervals by ascertained results as displayed in the cost sheets. Where, however, the foreman or manager has not access to the cost sheets, or where these are not so kept as to define the establishment charges, he must be content to accept a percentage given him by the bookkeeper or proprietor. It should, however, be remembered that nothing must be included for salary or personal withdrawals of the proprietor beyond such sum as would be paid any outside individual for similar services rendered, nor for any interest on capital which may also appear under the head of rent. This question of interest is, indeed, rather a complex one, and has been rendered more so by the amateurish attempts of professional auditors and accountants to distinguish between interest and profits in trades which they do not in the least degree understand.

The better and safer plan in estimates is to altogether omit interest, unless the buildings are the property of the firm and they pay no rent for them. In such a case, interest at 4 per cent or 5 per cent per annum on the actual cost of erection, less depreciation to date, should be included in lieu of rent. Neither shareholders nor partners should be credited with interest on capital; a portion of it is already provided for as interest on tools and machinery, and a further portion we have just provided for in lieu of rent; but the remainder, which is interest on working capital, whether paid to a bank, a mortgagee, or the partners or shareholders, should be provided for under the general head of profit in making the estimate, otherwise there will intervene the complication of the financial advantages of one firm over another, a complication which does not in the least concern the customer, and for which he will not pay an additional price. Whatever mode is adopted of dealing with interest should, however, be adhered to continuously, and the basis should be clearly understood by both the compiler of the estimates and the accountant who furnishes him with the percentage of management charges.

We have now arrived at the estimated gross cost of the boiler, and to turn this into the tender we have only to add the amount required for profit. Probably few of our readers will be required to determine this item themselves, but they may often be asked for advice, and it is desirable they should give the advice with as much wisdom as possible. In some firms it is the practice to add to the total estimated cost 10 or 15 per cent for profit, but, although this may afford a basis for computation, it is subject to many modifying considerations. The chief of these is the necessity for keeping the machinery and permanent staff fully employed; any idle machinery or partially-employed administrators increase the ratio of establishment charges, and, consequently, the cost of the work. The next is the position of competing firms with respect to work, the same necessity for reducing the ratio of establishment charges operating to induce them also to reduce the margin of profit. A third consideration is the general outlook of the market, and this, in certain conditions of trade, becomes almost paramount. If the market is rapidly rising, and the conditions are such as to indicate a continuance of prosperity, it may be better to allow machinery to remain idle for a week or two than to accept present prices, and be unable to undertake work at the higher prices of the immediate future. This, however, is a commercial question, on the determination of which the engineer should be guided by a commercial expert. It would be as absurd for the engineer to endeavour to forecast the state of the market without a knowledge of the conditions thereof, as is the endeavour of some commercial men to revise his estimates and cost accounts without having the technical training necessary for so doing.

The model specification which we have given is for an iron boiler. We will compare it with another specification for a Siemens steel boiler, and our readers will then see the necessity for detail in the preparation of the estimate. With regard to examination, in addition to the three for the first boiler, notice has to be given to the inspecting engineer when the boiler is in process of being drilled, and no plate is to be passed for use in the boiler which is not up to the specified thickness and weight, the margin for variation being *above the* specified thickness and weight. In the first case the boiler is for delivery by rail at ——. In the second it is for delivery in good condition on its seating at works in Cork. In the second boiler the internal flues are to contain six steel Galloway tubes ; the plates are to be bent cold, and no punching is to be done for any purpose to any material used in the construction of the boiler. The plates and angles are to be scoured entirely by a strong solution of sal-ammoniac, to remove the black oxide from the surface, before being put together, and the hydraulic test is to be applied both on completion at the maker's and again after it has been seated at the purchaser's works. Extra branches are also to be provided. If the specification is gone through with a form of estimate detailed as in the form we have already given, the engineer will not be liable to overlook the additional conditions or fittings which are demanded ; each item appearing therein will draw his attention to the specification before him, and so to any variation from ordinary or previous stipulations.

Since the first edition of this book was published the equipment of many engineering establishments has undergone serious modification, and the alteration is still in progress, and extending. Labour saving and automatic machines have been adopted, and electric power largely substituted for steam or hydraulic power. These substitutions have materially affected cost of production, both in the "Total Estimated Net Cost," and in the "Total Estimated Gross Cost ;" and care must be taken to give due effect to them whenever the estimate is based upon the results of work executed previously to alterations and improvements being made. In the former total the amount of wages will be reduced whenever machinery can be substituted for manual labour, and also whenever the speed of machines can be increased by the use of electric power. On the other hand, although the second total ought to be reduced (otherwise the improvement is only a financial disaster) it will not be by the same amount as the net cost. The new machinery has [illegible] greater sum than the plant which it displaces, and therefore "The interest on the present capital charge" will be increased. And for the same reason the depreciation will be higher, even when the life of the machinery is extended. The estimated repairs may, however, be less in consequence of the machines being new. The result will be a higher percentage on the estimated wages to be added for use of machinery and tools. The management charges may also be affected by the change from Gas to Electric Light.

During the transition period, through which British engineering firms are at present passing, these points should be remembered, and allowed for; when the conditions again become equalised the difficulty will disappear; but it is likely to remain a very real one for some years to come.

## CHAPTER II.

### GAS AND OTHER ENGINES.

We have dealt so far with a very simple form of estimate; the variations in boilers are much less than in other forms of machinery, and the division into parts or sections on the estimate is not of necessity so complete. In the case of a motor like the "Otto" or other gas engine, the details would be much greater; several items would require greater subdivision than would be needful for the shell and fittings of a boiler, and more consideration would have to be given to the various trades employed thereon. Let us look at a model estimate, based on an actual specification for a 20 horse power nominal gas engine.

### ESTIMATE FOR "          " HORIZONTAL HIGH-SPEED GAS ENGINE, OF 20 H.P. NOMINAL, MAXIMUM I.H.P. 60, AT A SPEED OF — REVOLUTIONS PER MINUTE.

| | Weight or quantity. | Price. | Material. | Salaries and wages. |
|---|---|---|---|---|
| ONE "          " HORIZONTAL GAS ENGINE, COMPLETE. | | | | |
| Fitted with— | | | | |
| Heavy flywheel, 7 ft 6 in. by 14 in., supported by outside pedestal and standard | | | | |
| Pulley | | | | |
| Galvanised iron water vessel | | | | |
| Patent cast-iron gas bag | | | | |
| Wrought-iron silencer for exhaust | | | | |
| One set spare parts | | | | |
| Patent igniting tube | | | | |
| Patent timing valve | | | | |
| Patent safety gear | | | | |
| Skew-gear wheels for side shaft and casing | | | | |
| Quiet air suction | | | | |
| Loose liner and piston | | | | |
| Steel connecting rods | | | | |
| Steel side shaft and covers | | | | |
| Patent pump starter | | | | |
| Sensitive electric light governor | | | | |
| Crank shaft | | | | |
| Gun-metal brasses | | | | |
| Testing and indicating | | | | |
| Foundation bolts, gas, water, and exhaust pipes and cocks | | | | |
| CARRIAGE TO | | | | |
| ERECTION AT | | | | |
| SUNDRY STORES | | | | |
| LESS scrap iron and steel | | | | |
| ADD cost of materials | | | | |
| TOTAL ESTIMATED NET COST | | | | |
| ADD—Use of machinery and tools | | | | |
| Management charges, including superintendence, rent, rates, insurance, gas and water, &c. | | | | |
| TOTAL ESTIMATED GROSS COST | | | | |
| ADD FOR PROFIT | | | | |
| TENDER | | | | £ |

We have selected a gas engine of ordinary type as an example, because it is precisely one of the class of machines which we have referred to as usually given in engineers' catalogues with prices affixed. A cursory glance at the estimate will, however, convince our readers how desirable it is to have a *standard estimate* for a *standard type* of machine. In purchasing an engine the purchaser will very frequently indicate some variation he desires; some portions omitted, or some additions made; and unless there is a detailed estimate in existence, which shows how the total price of from £350 to £400 has been arrived at, it is difficult to properly adjust the cost of these variations. Indeed, although the form we have given pretty fully specifies the various parts of the engine fittings, and might therefore be sufficient to recall to the estimator's mind the several items for which he must provide, we think for a standard estimate for a catalogue it should be given in even more detail. Thus, instead of giving merely the weight and cost of the engine proper under one sum, the cost of the work performed thereon by the several trades should be distinguished. Again, the flywheel is specified to be "turned on face, rim, and boss, and partly inside rim; and to have grooves inside rim and boss to prevent throwing of oil." The pulley is also to be "turned on face, rim, and boss." Now, as this means something more than mere labour and material for shaping the flywheel and pulley, and as both method of construction and cost of such secondary labour are liable to vary with lapse of time, it is always desirable to know the cost inserted in the standard estimate. The crank shaft is "to be cut out of a solid steel forging, machined, and polished all over." Here again the possibility of variation is such as to render desirable the separation of the material—that is, the forging—from the items of labour afterwards expended on it.

In a subsequent form of estimate we have shown the method which will generally be found convenient for analysing the labour into the various trades employed.

This undoubtedly entails a little more trouble, but the advantage it presents of greater detail of anticipated cost will, by many employers and managers, be considered more than compensatory.

"The engine to be delivered and fixed, &c." (subject to certain limitations), is a very ordinary announcement in engineers' catalogues. Of course they expect by adjustment of averages to compensate themselves for the long distances they have, under this clause, to send both men and materials, but in considering, as must sometimes be done, the desirability of accepting an order from a remote corner of the country, it is needful to see exactly what has been allowed for the service. Drawings, patterns, and moulds will, in standard types of manufacture, last for so long a period, and for so many successive constructions, that we may very reasonably include them under the head of management charges; probably with greater accuracy than if we endeavoured to anticipate them as a distinct item.

Whatever form, and however detailed the estimate may be for these standard types of machinery, the cost sheets of the firm should be so arranged as to check the several items thereof. An average of the cost of the various engines and machines, such average being divided under the several detailed items, should be made each year, and the estimate corrected thereby. The price to the purchaser need not of necessity be altered; the variable factor will be the added profit, but this factor is of such paramount importance to the success of a business, that most proprietors and boards of directors will be glad to see it graphically placed before them. Yet herein lies a lesson which we hope employers, whether sole or corporate, will pardon our again referring to, and that is the necessity for free and cordial conference and co-operation between the members of the staff on matters of cost and finance, and the desirability of greater confidence being reposed in them than is generally done at present. It will readily be perceived that few engineers have either the knowledge or the time to make themselves acquainted with the details of costs, and the building of them up into nominal accounts, so as to solve these commercial and financial questions, without book-keeping assistance. On the other hand, no accountant can furnish the necessary data, unless he has ample access to the accounts of the firm, and considerable knowledge of its business operations and anticipations. It is becoming too much a fashion to seek from professional auditors advice and assistance which should be rendered by the engineering and office staff within the yard, and the unfortunate result is that a very important section of the work is altogether neglected by the staff, or performed by them, under direction, in a perfunctory manner only. Without desiring to impeach the qualifications of professional auditors and accountants, we must earnestly contend that no man, visiting a works once in 6 or 12 months, or more frequently judging it by trading accounts and balance sheets prepared by his clerks without his personally visiting it at all, can so wisely and well advise the proprietor as can an intelligent book-keeper who devotes his life's energies to the business. We all know the adage about locking the stable door after the steed is stolen, and unfortunately the auditor's advice is generally, and of necessity must be generally, of this order. A careful selection of managing and office staff, and the repose of considerable trust in those worthy of it, is one of the first necessities for the successful conduct of an engineering establishment, and our capitalists would be furthering their own interests by more widely following this policy, than by relying extensively on the wisdom of outside and empiric advisers.

If we turn to the catalogue of a mechanical engineer or machine-tool maker, we shall find a vast variety of machines offered for sale, of standard types, and made to standard patterns, the prices for which are only revised in cycles of years, or reduced to favoured or influential customers by means of increased discounts. Now, as these increased discounts, even when they are only occasional, are equivalent to a reduction of price, it is most desirable that the commercial department of the firm, the outside managers, travellers, and salesmen, who are employed to dispose of the wares, should be furnished with an absolute and reliable guide to the margin of profit which is secured by the standard price, and which on an emergency they can modify. Without some such guide, or with only the information afforded by an average percentage of general profits, very grave blunders may be made. The average profit on a machine-tool making business may be, say, 10 per cent, but this will not be the rate of profit on any particular tool. On a radial drilling machine, for instance, where the maker has an improved design, or special facilities for the work, or on a lathe or planing machine, where his name is a guarantee for accuracy and finish of work, the profit may be very much higher than the average, whereas a punching and shearing machine, which contains more weight of crude metal in proportion to skilled labour, will possibly produce less than the average return of profit. To send a traveller out, therefore, with an intimation that he has, under certain circumstances, a margin of 5 per cent for extra discount, or other form of reduction on all his machines, might possibly have a disastrous effect on the gross profit of the firm. Nor does the difficulty quite cease with types of machines, for these vary not merely in size, but also in construction and elaboration, according to the special purposes for which they are designed, and this variation necessitates separate estimates and limitations of discounts.

Thus, if we consider that very necessary equipment of any engineering work, the lathe, we shall find them vary not merely in size, but also very greatly in details of construction. We have thus a "chasing lathe" (we are quoting now from a catalogue widely diffused by an eminent north-country firm), but this is only the first of a list of lathes, each of which has some special advantage to recommend it, and an estimate of the cost of construction of one would be absurdly out of place for another. We shall, however, revert to these catalogue prices in a later article.

The modern steam engine is a marvel of mechanical ingenuity and skill, not merely in the perfection of its general arrangement, but also in the perfect adaptability and finish of its several parts. But the very perfection to which it has been carried renders imperative equal skill in estimating for it in tenders for which the competition is keen, and, unfortunately for employers, keen competition is more generally the rule than the exception. The estimator should clearly fix in his mind that he is not tendering for one simple structure, as in the case of a boiler, but for a number of separate structures which have finally to be combined and worked together, and for which he has to give a single price in this combined condition. When this *motif* is properly grasped, he will readily see that the cost of each portion must be as carefully worked out as if it were a sole machine, and that to these separate costs must be added that of combining and erecting them into one great motor. The form of estimate will be on the same lines as that for the gas engine, but the sub-headings will require to be more detailed; some of the portions of work having each distinct trade expressed as a sub-heading. On this, however, no hard and fast line can be laid down; the experience of each engineer and the facilities of his establishment will be his best guide for these divisions, and if he cannot judiciously use such experience, he is unfit for the task he has set himself.

Let us consider the specification of a new horizontal triple-expansion condensing steam engine. The first item of expense to be considered is the preparation of detail and working drawings, and of moulds, patterns, and templates. In the instance of the gas engine we said that these expenses might be included under the head of management charges, as the drawings and patterns will last for many successive constructions of a standard type. But in the case of steam engines the same reasoning does not apply. The variation in arrangement, or in particular parts, is so frequent that the draughtsman's work on one steam engine will seldom serve for a second one without some modifications and adjustments which involve labour. We are strongly of opinion that the labour of the drawing office and mould loft on any one engine of a variable type, so far as it can be separated from other work, should be deemed available for that one alone, and that no portion of it should be carried forward against subsequent orders, unless the orders for duplicates are at the time actually placed, or there is a very immediate probability of them. The estimator must, however, avoid the other extreme, and must not charge a second time for making patterns, &c., which he has already in store. The existence of such patterns may give his firm an advantage over their competitors, and this advantage will appear in the reduced amounts of "Total estimated net cost" and "Total estimated gross cost," but, at the same time, the attention of the principal should be drawn to the fact, so that he may consider its bearing when fixing the amount to be added for profit. In many cases the possession of patterns may imply an increase of profit; in others it may simply imply prospects of successful competition through reduction of price.

Let us take this engine specification in detail. It is to be of "suitable strength for working with a boiler pressure of 180 lb. per square inch, with a piston speed of 630 ft. per minute, and revolutions 70 per minute." If the finished engine does not come up to these requirements, there will most certainly be trouble with the purchaser, if not rejection on his part, even though the failure cannot be traced to any specific neglect of the contract. Care must therefore be observed to make the various parts not merely as strong as the purchaser demands, but so strong as to ensure compliance with this initial requirement. This must be remembered when preparing the estimate, as well as in the execution of the work, if the contractor is to be protected against loss.

In the cylinders it is well to divide the labour into casting, boring, planing, drilling, and fitting. If the cylinders are of a larger type than are usually cast in the shop, some allowance must be made for the possibility of a failure in that process. The material will, of course, be available for future use after breaking it up, but the labour expended on it will be lost. Even in foundries accustomed to the size of casting required there is always a possibility of failure, and an average must be taken of such failures in the past, and the necessary percentage added to the estimated labour on the present. The cost of a casting to the manufacturer is not merely the labour expended on the solitary one which may prove a success, but that cost plus its due proportion of the unsuccessful efforts which have produced the needful skill. Here, again, we can lay down no hard and fast rules. Observation of men and appliances, and study of past successes and defeats in the identical shop, are the needful equipment of the engineer and estimator.

The valves and valve gears require very careful consideration of the specification, not merely on account of the many variations therein, but because the materials are now becoming of a more expensive character than mere cast iron. The weight of gun-metal steps and pedestal brasses should be carefully estimated, and not "lumped in" with the remainder of the material. The estimator must also consider, as far as he can forecast the future, what proportion of the fittings he proposes to make on his own premises, and what proportion he proposes to purchase from other manufacturers. The reason for this is obvious. If the establishment charges are divided, as they rightly should be, in proportion to wages only, then the internal making or external purchase of these fittings will affect the amount added for establishment charges on such fittings, even if the cost of them be left unaltered; and the amount added for establishment charges is an important portion of the estimate.

Blow-through valves, cylinder fittings, and indicator tackle should each receive a separate line for estimate of cost. In connection with these the objectionable phrase "an approved type" is very frequently used, and the engineer must, therefore, be careful to estimate for the best articles the market offers, judging the quality chiefly by the price. With such a clause in the contract it is very difficult to induce the inspector to accept any but the highest-priced fittings which can be obtained.

Cylinder covering, pistons, piston rods, crossheads, piston-rod sockets, and connecting rods should each receive a separate line in the estimate.

Crank shaft, crank pins, cranks, and crank-shaft pedestals should also be separately estimated for, and the specification carefully searched for any special conditions.

The engine beds in the specification before us are required to be "of strong design." This clause again throws upon the contracting engineer the responsibility of providing beds of sufficient strength to prevent any danger of oscillation, and he must be careful to fix in his mind the proportions he proposes to give to this portion of the machinery, so that he may properly estimate for it. He must also consider the various specified requirements for fitting of the beds and for foundation bolts, so that he may duly estimate for the labour required. The fly-rope drum should be separately estimated for in similar manner.

"It is essential that the governor should be capable of controlling the engine without sensible variation of speed." Here again the first consideration is one of an engineering character; the contractor has to determine, as a mechanical engineer, the capacity necessary for securing this result. He is confined to the "high-speed centre-weight type," but subject to that and other conditions as to fitting and finish, &c., the determination of the control to be exercised is left to him, and this decision more or less affects the cost of the work.

The air pump and condenser are again specified to be of "strong design," thus throwing the responsibility of the design upon the contractor, although the specified requirements and directions are sufficiently drastic. Steam and vacuum gauges are to be of "Bourdon's" make, and will therefore be purchased from an outside agent; but it is well to note that the steam gauge is, as usual, required to register up to a higher pressure than the maximum working pressure of the boiler.

Injection and overflow pipes, regulating valve, intermediate and exhaust pipes, receivers, steam pipes, knock-off motion, lubricators, hand rails, and spanners should each receive a separate line in the estimate.

A steam barring engine is demanded in the specification "of strong proportions and approved design, properly finished and polished in the usual parts, to be planed on the base, and bolted in front of the rope pulley on two cast-iron beams, which must be planed and prepared to receive it." This, of course, will demand a separate line in the estimate, and very careful consideration of the cost after study of the purchaser's requirements, so far as they can be ascertained and fixed.

The last item for consideration is the delivery and erection of the engine, which should be carefully studied in the specification submitted to the contractor for tender. It is generally embodied in an omnibus clause at the end, and all the various requirements which the intending purchaser thinks he may have previously omitted are here set forth in vague but comprehensive terms. Care should therefore be exercised that nothing is thus included which is not in some form or other provided for in the estimated cost. It is necessary to notice carefully what labour will be provided by the purchaser, and what is to be supplied by the contractor. Although the division of labour between the two is pretty generally on the same lines, any indefiniteness of apportionment will be interpreted strictly against the contractor, who, after all, undertakes to build the engine and erect it in place. It sometimes happens that he has to remove and take to pieces an old engine which the new tage to be derived from such elaboration. It is sometimes imperative to submit a tender without first calculating the cost—to make a purely speculative bid for a contract, trusting much to good luck and good works management to render it profitable. This is not good business, but is rather of the nature of a betting transaction—a bet, however, which is more or less in favour of the party who most skilfully uses such knowledge as is available at the moment. An old estimate, approaching most nearly to the engine now required, will be most serviceable, and the value of it will largely depend on the amount of detail it contains. If the several items of cost are fairly well divided, so that the points of divergence between the motors can be noticed and allowed for, a tender price may be arrived at of approximate accuracy. If speculative business must be done, it is well to reduce the speculative elements to the smallest possible number.

There is, however, another and equally important reason for elaboration, and that is the desirability of comparing actual cost of construction with anticipations thereof. A triple-expansion engine has been tendered for at a price of £3,000, a price which was understood to cover a good profit, but when it is completed the contractor finds that it has actually cost him £3,200 in direct and establishment charges. It will readily be understood that the interview between proprietor and manager is not a happy one, and less so when neither of them is able to detect the exact point or points of difference. When the estimate is so fully detailed and the cost accounts so kept that the loss can be localised, the advantage to the temper of both master and man is considerable, and, though no investigations can retrieve the present loss, they may result in more economical working in future. But to seek for a difference between estimate and cost in such a sum where only two figures are given (the anticipated total cost and the profit) is like searching for the proverbial needle, and with just as satisfactory result. The warning is not

THE NEW YORK
PUBLIC LIBRARY

ASTOR, LENOX AND
TILDEN FOUNDATIONS.

NEW YORK
C LIBRARY
, LENOX AND
FOUNDATIONS.

| |
|---|
| **Main deck** |
| **Spar deck** |
| **Ceiling** |
| **Stanchions** |
| **Engine and boiler seating** |
| **Engine and boiler casing** |
| **Bunkers** |
| [illegible] |

r we have known even larger contracts ave yet referred to taken for machinery, ble trace of the figures or mode of thought estimator based his computation. When shed, and a heavy loss incurred, he was no than any stranger to explain in what ork the increased cost had been incurred. s was very bad management, but probably a case as may at first sight appear. h civil and mechanical, have far more es cast upon them than mere office routine, g the higher duty they are apt to neglect or r one. This should not be, and the perfect so apportion work and responsibility that be neglected merely because he has not time personally.

---

## CHAPTER III.

### STEAMSHIPS.

n from land to marine engines, and to the ropel, we shall find increased complications, necessity for careful estimating. In such ns of work, most of them passing through two s, and requiring the employment of divers men, it is difficult for the most skilful and mator to avoid omissions and errors; and mp sum is frequently added to cover such most uncertain protection to rely upon. We example a screw steamer, intended to convey tons of petroleum on a mean draught of salt water, and our readers will from the ate see how many points have to be carefully considered. We must draw attention to the initial requirement of the cargo weight to be carried, and the draught to be observed. If this is not adhered to, the steamer will be useless; and as no drawings or designs are furnished by the purchaser, the first business of the builder should be to prepare these. He must then obtain the approval of them by the purchaser, and, if possible, his assumption of responsibility for them. Unfortunately, the latter is usually a difficult task, and both the purchasers and their professional advisers protect themselves in every possible way against relieving the contractor from the onus of supplying a vessel which will fully comply with these preliminary conditions.

So far, we have in the model estimates used only one column for wages and salaries, without distinguishing the several trades, unless under particular headings in which it is deemed desirable to further divide the wages. In many cases, however, the proprietor may require the estimates to follow more closely the lines upon which his cost accounts will be compiled, so that he may not only compare the total actual expenditure on keel, stem, and sternpost with the estimated expenditure, but also compare the estimates of the wages paid to shipwrights, platers and riveters, fitters, blacksmiths, &c., with the completed results. For this purpose the columnar form which follows will be found useful, and the columns may be extended to any number of divisions found necessary. It may also be applied to engines or machines, though it will probably not be so frequently demanded for these as for more complex structures such as ships.

The first item we have on the estimate is "Drawings, laying-off, and model." We have already pointed out that the drawings and moulds of any one stationary steam engine can seldom be relied upon for service in the construction of a second without some cost for alterations and amendments. Not only does this apply more forcibly in the case of a steamship, but we may even conclude that the variations from previous constructions are so great and numerous that entirely fresh drawings and moulds are necessary. Former drawings may, it is true, assist the designer, but only to the extent of refreshing his memory and ideas. The actual working and other drawings have almost invariably to be newly prepared.

The next item, "Laying blocks," covers both labour and materials. The former is comparatively easy to arrive at, being the expected actual wages of labourers and shipwrights in fitting the blocks in place for reception of the keel and frames; but the latter requires more consideration. Some of the blocks will be so cut about after the launch as to be useless for anything beyond firewood, whilst others, after perchance a little trimming, will do to place under other ships or machinery. Now, the ship immediately under consideration should certainly be charged (both in estimate and cost account) with the blocks consumed during her construction, but with nothing more; the user of the other blocks is provided for under the head of "Use of machinery and tools." It cannot be too often impressed upon our readers that this question of consumption is the crucial test of the charge to be made; this, if clearly understood, will save them from many blunders which they might otherwise make.

The next three items, after laying blocks, bring us immediately in contact with the heavier portion of the material used on the ship; and the weight of the keel, stem, and stern post, frames, and plating can be furnished by the draughtsman with great approximate accuracy. But the work to be executed is not always in exact proportion, ship by ship, to the weight of the materials required, and it is therefore needful to carefully study the details of the specification. For instance, the frames may be of the ordinary character of angle iron, or they may be required of Z iron. The difference in the cost of framing two ships with these diverse frames will be much greater than is represented by the difference in weight of material: the extra labour and care required in bending the Z irons will have to be allowed for.

Bulkheads will be included in the weights furnished to the estimator by the draughtsman, but it is necessary to note how many of them are required to be fitted with water-tight doors, and in what manner these water-tight doors have to be worked, from what portions of the vessel, and by what mechanical appliances.

The vessel for which our model estimate is prepared is for the conveyance of petroleum in bulk, and it is important to consider the specification so far as the appliances for this conveyance is concerned. The hold of the vessel to the main deck, for about 190 ft., is to be divided into sixteen compartments by longitudinal and transverse bulkheads. Those at the after end of the oil compartment are to be of iron, $\frac{8}{16}$ in. thick for about 8 ft. from floors, $\frac{7}{16}$ in. to main deck, and $\frac{6}{16}$ in. to upper deck, and to be stiffened with vertical angle bars, 5 in. by 3 in. by $\frac{8}{16}$ in., spaced about 2 ft. apart; these bars to be connected to the stiffeners of bulkhead, forming water space, by gusset plates, $\frac{7}{16}$ in. thick; this bulkhead to be of plates the same thickness as the one at the after end of the oil compartment, and to be stiffened with angle bars, 4 in. by 3 in. by $\frac{7}{16}$ in., spaced 2 ft. apart. Similar bulkheads are to be fitted at forward ends of oil compartment, forming water space. A 2 ft. water space is also to be formed between stokehole and cross bunkers; these bulkheads being of similar plates, stiffened with 4 in. by 3 in. by $\frac{7}{16}$ in. angles, and connected together by $\frac{3}{8}$ in. gusset plates. The intermediate divisional bulkheads to be of iron, $\frac{8}{16}$ in. and $\frac{7}{16}$ in. thick, stiffened with vertical bulb plates and angle bars of the same relative scantlings and spacing as in the steamship Zeno. Two horizontal stiffeners, of same scantling, to be fitted on opposite side of bulkheads, and each bulkhead to be secured at deck, and to keelsons and floors, by strong knee plates. The longitudinal bulkhead *at* centre line to be of iron, $\frac{8}{20}$ in. thick, stiffened with *vertical angle* irons, 5 in. by 3 in. by $\frac{8}{16}$ in., spaced 36 in. apart, on alternate sides, and to be securely riveted to the deck plate by double angle bar, 3½ in. by 3 in. by ⅜ in., in short pieces, between beams, and to the centre keelson, which is to be 2½ in. deeper for that purpose. Between the centre line bulkhead (which is to be carried throughout the oil space to the upper deck) a longitudinal stringer is to be fitted, composed of plates $\frac{7}{16}$ in. thick, and secured to the main deck beams and plating by angle bars, 3 in. by 4 in. by $\frac{7}{16}$ in., worked in a suitable manner to take the heads of a row of quarter pillars, which are to be fitted alternately, not less than three on each side, in each compartment; 3¼ in. diameters secured with two rivets, at head and heel, and the fitting, &c., of the heels to keelsons to be as in the steamship Zeno. Filling tubes to be fitted to each compartment, and secured as per a sketch to be submitted and approved before the work is commenced. A gas-escape pipe, and also indicator to show height of oil in compartments, are to be fitted, and properly protected against injury by plate wrought-iron covers. Sluice valves, worked from the upper deck, to be fitted to each pair of oil compartments, and hose pipes and couplings to wash deck pipe opposite each filling tube.

The pumping room to be of $\frac{3}{16}$ in. iron plating, well stiffened with angle iron, 2½ in. by 2½ in. by $\frac{5}{16}$ in., with iron door, side-lights, and ventilator, as shown on plan. For the oil-pumping arrangement there are two pairs of double-acting Worthington steam pumps complete, with all steam connections, to pump at the rate of 1,000 gallons of oil per minute each pump, with two sets of pipes, so that the oil of any separate tank may be pumped into any other tank, and means provided from each pump for pumping out water from between decks if necessary, and suitable strainers fitted. The lead of the pipes is strictly laid down so as not to pass through the coal bunkers, and a complete detailed sketch is to be prepared by the contractors, showing the whole of the pumping arrangements and valves in connection with the Worthington pumps, and submitted for approval before the work is commenced.

We have omitted several of the details which will be found in the specification in reference to oil storage and pumping, but we have named sufficient of them to show our readers how very much greater the cost of construction will be than that of an "ocean tramp." It is not merely the extra material, but the additional labour, and chiefly skilled labour, which must be considered, and this consideration demands a minute and careful reading of the specification. The engineer and draughtsman who would escape the Scylla and Charybdis of tendering, who would avoid asking too high a price, or accepting too low an offer, should not hasten their perusal of the requirements submitted to them, nor think the time wasted which they spend in grasping the details thereof.

The main deck is to be of iron, of varying thickness, $\frac{10}{20}$ in. thick in range of petroleum compartments, but only $\frac{8}{20}$ in. in other portions. Very stringent requirements, however, are laid down as to deck beams and stringer angle bars, which must be duly allowed for in the estimate. It must also be noted that "the whole of the main deck work in the vicinity of the petroleum compartments is to be boiler riveted."

Web frames are to be fitted in each petroleum compartment, instead of hold beams. The spar deck is to be of steel amidship, and iron at ends.

The whole of the edges and butts of the plating of bulkheads, decks, &c., in wake of petroleum compartments are to be double riveted.

In the cabin fittings there are no very special demands, but it should not be overlooked that whilst the captain and officers are accommodated in a deck house aft, an additional day and night cabin, with bath and pantry, &c., have to be fitted in the midship deck house. The plan should be studied to ascertain what fittings are really required for this cabin, as they may possibly be more extensive than is revealed by the mere wording of the specification, seeing that it is intended for the use of the owner or his friends.

The electric lighting is comparatively a new demand on the part of shipowners, but in future it will probably be extensively used on board ship. Two dynamos are to be provided, and also spare gear. Probably in most yards this work will be sublet to outside contractors, and where this is intended it is well, when time permits, to obtain a tender from one or more electrical engineers. It must be observed, however, that the lighting is to be "on a system approved by the purchasers."

The outfit and stores to be supplied by the builders are usually of the same character for any given class of vessel, and vary only according to her size. The list should be inspected to ascertain if any additions are inserted, and the general conditions also scrutinised. We have occasionally seen in the latter some such clause as this: "No necessary and reasonable requirements of the purchasers shall be withheld by the contractor, nor charged for as an extra on account of its omission from this specification. The whole of the work to be to the satisfaction of inspector appointed by the purchaser, who shall have power to condemn all faulty workmanship and material." Such a drastic clause places the purchaser in a very commanding position, and whenever possible something should be ascertained of his business character: if he or his inspector are likely to use the clause in an unscrupulous manner, then provision should be made for it. It is far better to lose an order than to build for some owners under such conditions.

Let us turn to the specification of a despatch vessel for Government service. The first characteristic we notice is the extreme care with which it is drawn up, and the great detail with which the various items of hull machinery and fittings are given. From 30 to 40 pages of closely-printed foolscap is no unusual length for such a specification. The reason is obvious. Not only does the British Admiralty possess an exhaustive record of its previous ships, and of their performances and defects, but it has also a highly-trained staff of naval constructors who will so use those records as to avoid ascertained mistakes in future. Foreign and Colonial Governments also who build vessels in England employ British naval architects to design and superintend the construction, and can readily find in the members of the institute some of the most eminent and capable designers in the world. This very voluminousness is at once a benefit and snare to the estimator : a benefit if he will take the trouble to study each particular clause, and calculate its effect on the total cost; a snare if he tires of the seemingly interminable task, and endeavours to shorten it by taking some previous tender, and adding to or deducting from it a lump sum for increased or decreased length. The next point to be observed is that the general covering clauses are extremely elastic, and usually bind the contractor to the utmost attainable perfection of design, material, and workmanship. No mistake must be made in supposing these clauses to be a mere bogey intended to frighten the builder into reasonably good behaviour; they will, on the contrary, be strictly enforced, and nothing will be accepted by either inspectors or their superiors unless it is of the very highest class in both material and workmanship. The estimator who has not been accustomed to Government work should therefore remember that work which will satisfy the inspector of an ordinary merchant vessel will not pass the scrutiny of an Admiralty overseer, or of a naval attaché from Chili, Japan, or St. Petersburg. The appliances in the building yard and the machinery which can be devoted to the work will impress the inspecting officers, and any defects in these, even though they may be overcome by judicious management, and not in any way prejudice the work, will probably cause a little friction at the commencement. This may be provided for in making the tender, although more properly it should be dealt with along with other considerations in fixing the item of profit, but at the same time it should not be over-estimated: perfect loyalty to the specification and contract, and honest desire to produce good work, will be appreciated by the greatest martinet.

Government work generally, and all classes of work for municipal and county authorities, will require this careful consideration. The inspections are becoming more stringent, and the interference of officials more annoying year by year, and it is usually only firms which lay themselves out specially for such work that can make any profit out of it. It is not merely engineering skill which is needed, but skilful use of some of the teachings of Nicolo Machiavelli.

It will be better to increase the items in a ship of this character, so that nothing may be overlooked, than to endeavour to group them within the limits of an ordinary merchant ship. The specification requires many fittings in coal bunkers, shaft alley, water-tight doors, entry doors, coaling ports, mast steps, ash shoots, &c., which are not to be found in merchant ships except "greyhounds" of the very highest order, whilst gun ports, magazines, and military storerooms are incidental solely to a warship, and yet are of most material importance in the cost of her construction.

The names of the makers of the steel, and also of the copper bolts, and of fittings proposed to be purchased, are usually required to be submitted for approval to the inspecting officer or his superiors. There are, however, so many firms in England and Scotland of the highest eminence competing for steel and copper orders, that this limitation need cause no increase of expenditure, nor trouble in procuring materials. When, however, we turn to the woodwork, some difficulty must be anticipated, and provision made for it, as the natural growth of trees does not always satisfy the ideas of the inspectors. In the vessel we are considering, "the flats of all decks are to be of good East India teak, free from all defects," and under this clause we may be sure that any plank with the slightest shake or worm hole in it will be summarily rejected. The teak will not be passed in log, as it might possibly be for a merchantman, but each individual plank will be carefully scrutinised by the chief overseer or one of his Argus-eyed assistants. "Very great care is to be taken to keep the seams uniform and regular throughout, and thus to give to the deck a good appearance," and the decks are to be hand planed shortly before the vessel is handed over. It will be understood that under such conditions as these, which will be strictly enforced, many logs of teak may pass through the saw mill without a single usable plank being obtained from them.

The undersides of the decks in contact with steel are to be thickly coated with red lead, and the waterways are all to be well bedded in lead paint. It is well to remember that what is known commercially as "pure red lead" will not satisfy the naval inspectors of this or any other nation. It must be as nearly intrinsically pure as chemical skill can render it. The tests are usually severe, and will be repeated at uncertain intervals throughout the building. Special attention should also be given to such items as steering gear, armament fittings, davits, steam winch, derrick, guard rails and stanchions, skylights, ladderways, &c., the regulations for which are stringent in vessels of this class. Sheep pens and fowl coops, guest warp boom, deck plates, ensign staff, signal-rocket fittings, rollers, gratings, locks, and prisms will also require consideration, as they are both more numerous and of a much higher class than in a cargo boat or coasting passenger steamer.

The cabin fittings should be carefully studied. If the vessel is built for a Government situated in the tropics, or as a cruiser intended for service there, such additional fittings as punkahs and extra ventilators will have to be provided: indeed, for tropical service the ventilation required throughout the vessel will be elaborate and very costly.

The boats demanded on a Government vessel will be greater in number and more perfect in construction than for a steamer of similar size in the merchant navy. The spare gear required will also be greater.

If we examine the specification of a small composite paddle-wheel steamer, we shall find the difficulties of estimating scarcely inferior; indeed, it is more difficult to forecast the cost of a composite vessel than of one wholly of iron or wholly of steel, and as workers in iron and workers in wood are both largely engaged upon her, the danger of wages complications during her progress is greatly increased. The frame is to be of steel and the planking teak, secured by yellow metal fastenings. Copper sheathing is to be fixed to a height of at least 1 ft. above the load water line. No permanent cabins are required, but instead ample sitting accommodation is to be provided on the upper deck and below for both first and second class passengers. The decks are required of red pine, the bulwarks of seasoned yellow pine, and the ceiling of fir. It will thus be seen that even a small vessel requires careful consideration before tendering for her, and although the items of the estimate will be few in comparison to those of a despatch vessel, they must still be sufficient to draw the attention of the estimator to each point which demands his attention. For service in tropical waters, composite vessels are frequently used, and the cost of their construction differs materially from that of an entirely iron or steel ship.

We will take one more instance, of a large armed steamer, intended for the conveyance of troops or emigrant passengers. She is to be built of steel, with a length between perpendiculars of over 300 ft., an extreme breadth of 49 ft., and moulded depth of 29 ft. Her displacement is to be 5,000 tons, and indicated horse power 6,000. She is to be fitted with twin screws, driven by two pairs of independent triple-expansion inverted vertical direct-acting engines, supplied with steam from eight single-ended boilers. For the estimate we should use the columnar form previously given, dividing the estimated labour into the various trades employed in the yard, but using many more items than are employed in our example. The differences between an armed trooper or subsidised steamer and the ordinary cargo boat are so great, not merely in general design, but in workmanship and arrangement of almost every item, that the estimator should not neglect any precaution which may be available against overlooking some increase of cost, and one of the precautions he can take is this multiplication of items. We the more strongly insist upon it because we know it is frequently neglected, on account of the increased clerical labour it entails; but although the neglect may have no evil results in a dozen successive cases, it will often, in the end, bring disaster or ruin on the firm which perseveres in it.

The first requirement which strikes us is that the vessel is to have four complete laid decks, viz., spar, main, lower, and orlop. Later we find that the planking is to be of teak throughout, of varying dimensions for the different decks, fastened with galvanised iron nut and screw bolts. The decks are to be planed on *both* sides, to be well caulked, and the spar deck to be afterwards payed with marine glue pitch, and the main, lower, and orlop with best pitch. On the spar deck a house is to be fitted for chart room, and captain's room, with flying bridge, chart room, and wheel house above. At each mast a steam or hydraulic winch is to be placed, a hydraulic capstan to be fitted aft, and a steam capstan and windlass forward. On the spar deck, arrangements are to be made for carrying twelve quick-firing guns and four boats' guns, and the necessary foundation supports must be fitted by the contractors as may be demanded. Underneath the orlop deck, aft of engine-room, is to be placed a quick-firing gun and a machine gun, and forward of boiler-room another machine gun, the foundation supports for which are to be provided. It will thus be seen that the decks, and deck arrangements and supports, will require careful calculation, since a considerable additional amount of heavy work has to be done on them.

The cabins and cabin fittings are also different to the ordinary arrangements thereof, and will require consideration with respect to their position, as well as number and fittings. On the main deck there is to be a saloon, capable of dining 48 persons ; cabin accommodation for 29 first-class passengers (gentlemen), in addition to a ladies' cabin, and rooms for the captain, chief engineer, and seven ship's officers. In the waist are to be arranged the engineers' rooms, mess, and pantry ; rooms for stewards, clerks, clerks' office, apothecary, and dispensary ; and mess rooms for the inferior officers or second-class passengers. Forward, in addition to the forecastle for crew and firemen, provision is to be made for petty officers, and horse stalls, stock pens, and wash places are to be fixed. The lower deck is to be left as free of obstructions as possible, being essentially an emigrant or troop deck, the women's quarters in which must be placed right forward, with the needful lavatory and other accommodation. Aft of these quarters provision must be made for twenty second-class pasengers. The orlop deck is to contain places for native servants, and store and sail rooms. Thus it will be seen that "cabin fittings" of a more or less ornate nature are spread all over the ship, and this wide distribution of cabins, mess rooms, and other quarters necessitates additional material and labour in providing extra pantries and bars.

Beneath the orlop deck, magazines, shell room, spirit room, provision rooms, stores, and cargo hold are to be provided.

The keel is to be of flat plate construction, but combined with a centre vertical plate, 42 in. deep, throughout the double bottom. The stem is to be forged of best hammered scrap iron, but the stern post is to be of cast steel, formed with two posts, with attachments cast on, as described. There is to be a double bottom, to extend for a distance of about 231 ft.

The magazines are to be fitted complete, with racks, dunnage battens, supply and return scuttles, fearnaught bags, metal hooks, overhead travellers, and elaborate flooding and draining arrangements. The gun supports are "to be of very strong construction," and pillars or deep bracket knees to be fitted under guns, if necessary, in addition to

The boilers in question are eight in number, and duplicates of each other. As they will not cost in wages eight times the expenditure on the first one, due allowance must be made by the estimator for the resulting economy.

In shipbuilding generally the draughtsman can furnish the weight of the steel plates and angles approximately from his sections, and the chief necessity which arises for caution is in the distribution of this weight over the several portions of the ship, so that none of it may be included twice. The estimator must also consider what sections of the work he proposes to do in his own yard, and what portion he proposes to purchase from manufacturers, erecting it in place only on his own premises, in order that he may properly adjust his establishment charges. If the stem and sternpost, for instance, are built up in the yard from hammered scrap, then the material will be entered at the cost price of such scrap, and the labour will include all the forging and shaping of the pieces; if, on the contrary, as is frequently the case, they are purchased from Sheffield forges, then only the cost of erecting them in place will appear under the head of labour. Consideration must also be given to each portion of the estimate, that no work may be omitted. Laying decks, for instance, must include labour and materials for such work as caulking, filling in with marine glue, trimming, and planing, although these are not actually mentioned on the face of the form.

Riveting is frequently placed as a separate item, in which case it should cover all the riveting throughout the ship, in order to avoid the danger of double charges, and the rivets throughout should be included in weight and value in the column of materials. Hatchways and hawse pipes are advantageously dealt with by themselves, because from their nature they require more labour and attention than is demanded for other portions of the vessel with which they are in immediate connection, and therefore require a different rate of calculation. Indeed, experience will very soon teach a foreman or draughtsman that the questions he has to deal with in estimating for a modern steamer are so numerous and varied, that he has to consider each of them with as much care as he would bestow on the entirety of a machine tool.

There is another point to be remembered in connection with shipbuilding which renders more imperative this minute estimating. It seldom happens that a cargo or passenger steamer, or still less a Government or war vessel, is built without some alteration being asked for during her construction. A pantry will be abolished, and a mail room substituted; a spirit room will be removed aft, and a magazine take its place; and the shipbuilder requires to know the amount he has set apart for that pantry or spirit room, as well as the amount so far expended on it, in order that he may compute the additional payment to be asked from his customers. Alterations of this kind may frequently be made exceedingly profitable to the builder, but only when he is thoroughly posted up in costs and estimates; the purchasers have their own ideas on the subject, and are skilful in recommending them.

## CHAPTER IV.

### CATALOGUE MACHINERY AND FOREIGN ESTIMATES.

LET us revert to a portion of the subject we have before incidentally glanced at, but not yet treated in detail; we mean such machinery as is usually included in engineers' catalogues, and sold at prices which vary but little from year to year. Purely commercial considerations, such as the convenience of a fixed price which can be quoted by any traveller or agent, and facility of reference by customers, are material factors in the compilation of catalogues, and these commercial considerations override any desirability for preparing separate estimates for each tender or quotation. But at the same time it is needful occasionally to revise the catalogue prices, not by any speculative anticipation, but by the results of past construction, and to enable this revision to be accurately and systematically conducted, it is desirable, if not indeed imperative, that for each machine there should be a model estimate. In a firm with a large number and variety of machines on their list, it will be found very convenient to have these estimates bound in one or more volumes, which volumes will be accessible only to the principals, their managers, accountant, and most trusted officials.

As we anticipate, possibly at long intervals, variation in the prices quoted for the finished machines, it is better to have these model estimates prepared for such variations, bearing in mind, however, that they are not cost accounts, but merely estimates on which the catalogue prices are based, and must therefore only be varied when the catalogue is amended. The following form will meet our requirement, if the lathe is fully described in the heading, the various details to be supplied enumerated, and the portions of the lathe, &c., very fully divided in the body of the estimate. This full division is even more desirable with catalogue machines and tools than with larger contracts, both on account of the longer time over which the estimate has to extend, and the many commercial complications which arise in connection therewith.

Now on this estimate for catalogue machines arises a question, which, indeed, will apply more or less to all constructions, namely, the price at which smaller portions of the machine, such as bolts and nuts, which are made in the works and placed in stock, should be charged. In a later section, when dealing with cost accounts, we shall show that it is necessary for accuracy of accounts that all articles made in the shop for the stores should be debited to the storekeeper at the actual cost of workmanship and material, plus establishment charges, and should be issued

### Estimate for Duplex Bolt Sliding Lathe, No. —— in Catalogue, 6 in. Lathe, 5 ft. Bed, Admits between Centres 2 ft. 2 in., Countershaft 170 Revolutions, Pulleys 10 in. by 2½ in.

**Details supplied: A top driving apparatus, the requisite screw keys, a Clement's driver, a set of hexagon and square bolt drivers, water pot, and sliding stay.**

| Names of parts. | Weight or quantity. | Materials. | | Salaries and wages. | | | | Materials. | | Salaries and wages. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Price. | Cost. | Moulders. | Turners. | Fitters. | Labourers, &c. | Price. | Cost. | Moulders. | Turners. | Fitters. | Labourers, &c. |
| Divide the various portions of the lathe, &c., very fully in this descriptive column. | | | | | | | | | | | | | |
| Less scrap metal.... | | | | | | | | | | | | | |
| Total Wages ................................ | | | | | | | | | | | | | |
| Add cost of materials ................................ | | | | | | | | | | | | | |
| Total Estimated Net Cost.......... | | | | | | | | | | | | | |
| Add—<br>Use of machinery and tools ..................<br>Management expenses, including superintendence, rent, insurance, gas, water, &c..... | | | | | | | | | | | | | |
| Total Estimated Gross Cost........ | | | | | | | | | | | | | |
| Add for Profit ................................ | | | | | | | | | | | | | |
| Catalogue Price .................... | | | | | | | | | | | | | |

**These columns may be extended across the book according to the width of it, but we should recommend room being taken for at least three estimates for each machine, so that there may be no difficulty in comparing them as compiled at various dates.**

by him for consumption at the same price. It is absolutely necessary for cost accounts which are to represent actual accrued results, that no profit should be shown in any department, nor any be made in the stores issues; but as estimates are not accurate accounts, but only the nearest obtainable approximations, the same reasoning does not at first seem quite to apply. And yet on a little further consideration it does so apply, and we shall find it desirable to include in the estimate all portions of the machines usually made in the yard at their actual cost to the storekeeper as representing the firm. Take, for instance, this example of bolts and nuts. The cost of materials, and of labour in making the bolt and nut, and afterwards in screwing them, is ascertained, and to this cost is added the proportion of establishment charges which have actually been incurred on that particular work. The bolt and nut certainly do not become any more valuable for passing over the storekeeper's counter and out again, and there is no more reason for making a stores profit on them, than on the iron which also passes through the warehouse. Our object is to arrive as nearly as we can at the cost of material and direct labour, and by adding to that establishment charges to ascertain the approximate gross cost of the machine. Having ascertained this gross cost, we add the profit, the amount of which depends on various considerations, and one of these may very appropriately be that we make bolts cheaper than we purchase them, and so may add more profit than we otherwise should.

We have already pointed out the desirability of calculating the establishment charges on the basis of the wages, and a little consideration of the items which for a ship would be purchased from an outside manufacturer will show the force of this. There is, however, one consideration with respect to these establishment charges which must be borne in constant mind. We have indicated the method of calculating the percentage of these charges, as on the wages on contracts running, and the wages on tenders expected to be accepted. A commercial question comes in here, which may be dealt with as a matter of profit, or as a reduction of the ratio to be added to the cost. If the yard is only half full of work, and expected to so continue, the interest on machinery, the depreciation, the current repairs, and also the general management salaries and charges, will bear a much greater proportion to the wages to be expended than they would if the yard were full, or nearly so, of machines or engines in progress. But this larger proportion cannot be exacted from customers, who are protected against any such extortion by the competition of rival firms; it must come out of the profit which may accrue from the work. To meet this difficulty it is with some engineers a custom to estimate the wages at the sum they would be if the whole of the machinery were fully running, and over that to spread the fixed charges, coal, &c. This certainly has the advantage of bringing the estimate nearer to the amount at which the tender can be rendered, but it has the disadvantage—and it is a grave one—of not showing the nearest possible approach to expected cost of the contract. The difficulty may, however, be met, and possibly this is the best plan, by making the estimate in the form, and on the lines, we have previously indicated, down to the line, "Total estimated gross cost," and then adding a supplementary one at the foot in this form:

| | £ | s. | d. |
|---|---|---|---|
| TOTAL estimated net cost as above ........................ | | | |
| ADD—Use of machinery and tools at a fixed proportion of —— % .................................... | | | |
| Management charges, including superintendence, interest, rent, rates, insurance, coals, gas and water, at a fixed proportion of —— % ........ | | | |
| TOTAL estimated gross cost .............................. | | | |
| ADD for profit ........................................... | | | |
| TENDER .................... ...£ | | | |

It is on this latter estimate the tender should be made.

We have indicated pretty fully the principles on which English estimates for boilers, machinery, and ships must be constructed. We can only, with any advantage to our readers, indicate principles, since a reprint of existing estimates, the figures of which must of necessity vary if they are not already obsolete, would be of little service to them. The engineer and manager who has to prepare estimates must rely largely on his own knowledge of the work to be undertaken, of the prices of materials, and of the capacity and cost of labour, for the success of his effort; he will indeed be most successful in proportion to the extent and thoroughness of his professional training or knowledge. We can suggest forms and methods of using them, but we cannot supply, nor do we think we need generally to supply, the brains which alone can render these forms serviceable. The assistance of the cost clerk, when permitted by the principal, will be extremely valuable, but only when he is employed in the establishment and daily conversant with all its details. The departmental costs accounts of an auditor who knows nothing of the business beyond its ledgers and vouchers, and has neither time nor capacity to understand its ramifications, will probably be more misleading than otherwise.

There yet remains one portion of the subject in which probably only a few of our readers will be interested, but to those few it is of vital importance; we mean the preparation of estimates for foreign work. There are various ways of doing this, and probably houses which regularly ship and erect machinery abroad so thoroughly understand their own particular methods, and make such necessary allowances for contingencies, as to arrive at a fairly satisfactory conclusion. After all we are dealing with anticipations, and not with realised results. But it is as well to eliminate as far as possible all causes of error, and to make as accurate an estimate as we can of the cost up to a certain point, before the disturbing elements come in. We therefore recommend the preparation of the estimate in the form already given, down to the line, "Total estimated gross cost," including in the net cost (under the column of material, to avoid error with establishment charges), the railway freight, and other charges necessary to place the goods F.O.B. at port of embarkation. This will give us the figure on which the profit would be computed if the order were an English one. But we have to add to these charges, which will vary considerably, according to the extent of work specified to be done abroad. In any case, if the machinery has to be delivered at a foreign port, there will have to be added the freight, and probably customs dues and charges, and the shipping agent's expenses on debarkation. In other tenders it will be necessary to add freight up country, labour for erection, partly obtainable in the country and partly sent from home, and European superintendence during erection, and trial working before acceptance by the purchaser. Having obtained our English "Total estimated gross cost," we must continue it in a foreign estimate of something of the style given on opposite page.

In calculating the freight, and also the charges up country, care must be taken to include the weight of the packages, and for the purposes of sea freight to reduce the packages to measurement tons. The charges of the Vera Cruz agent can be ascertained from the shipping agent on this side.

The freight per Mexican rail can be ascertained at their London office, and an approximation of the cost of transferring the goods into carts at Puebla. It must, however, be borne in mind that not only Mexican, but all the American railroads, both north and south, have an extremely erratic method of altering their rates without notice. If, therefore, the rates quoted on inquiry are abnormally low, it is well to increase them in the estimate so as to provide against railroad vagaries.

The passages of the workmen and superintendent can readily be ascertained from the steamship companies, but it must be remembered that the return passages will probably be paid in dollars, and will, therefore, be complicated by the question of exchange.

The erection of plant at the Hacienda will require careful

## FOREIGN ESTIMATE FOR SUGAR PLANT, TO BE DELIVERED AND ERECTED AT VICTORIA HACIENDA, 17 MILES FROM PUEBLA, FOR SENOR DON FRANCISCO DIAZ.

| | Dols. | Cents. | £ | s. | d. |
|---|---|---|---|---|---|
| Freight from Liverpool to Vera Cruz, —— tons, at ——.................................... | | | | | |
| Customs clearance and agent's charges in Vera Cruz (duties free)......................... | | | | | |
| Freight per Mexican Railway from Vera Cruz to Puebla, —— kilos., at —— cents per kilo... | | | | | |
| Discharging into carts at Puebla Station ...... | | | | | |
| Cartage from Puebla Station to Victoria Hacienda, at —— cents per kilo. .......... | | | | | |
| Passage of workmen (3) and superintendent from Liverpool to Vera Cruz .............. | | | | | |
| Erection of plant at Hacienda, viz.— | | | | | |
| Native labour ............................ | | | | | |
| European labour (3 men) .................. | | | | | |
| European superintendent ................ | | | | | |
| Travelling expenses in Mexico ................ | | | | | |
| Return passages of workmen and superintendent | | | | | |
| Use and loss of tools.. ........................ | | | | | |
| $ | | | | | |
| Mexican dollars taken at the exchange of 6·85 dollars to the pound ...................... | | | | | |
| GROSS COST after shipment at Liverpool .................. | | | | | |
| ADD GROSS COST F.O.B., Liverpool ........................ | | | | | |
| ADD FOR PROFIT—England ............................... | | | | | |
| Mexico .................................. | | | | | |
| TENDER ...................................... £ | | | | | |

consideration, because, although the rate of pay to native workmen is lower than that to Englishmen, the quantity of work they will turn out in a day is much less, and the finish of it will be very inferior. It is usual with some contractors to estimate that native labour will cost the same amount per unit as English labour for work where special skill is not required, the reduced rate of pay being taken to compensate for the reduced output of work. However, in Mexico and other Spanish-American countries Mañana is a power to be reckoned with, and it will probably be wise to add twenty-five per cent to native wages to provide for this potent factor. The Englishmen will also require more money abroad than at home, to compensate for the discomfort and expense of foreign residence. We have known £20 per month each, with furnished rooms provided, paid to ordinary bricklayers.

The question of exchange demands careful attention. The expenses abroad and the cost at home require stating in money of the same denomination, and we have adopted sterling for it. This is on the assumption that the payment will be made in sterling. If the tender is given in Mexican dollars, and the payment accepted in such coin, then the process must be reversed, and the sterling amounts reduced to dollars. We need hardly observe that this is an extremely undesirable method of payment, so long as the fluctuations in the silver market continue as great as they have been in recent years.

The question of profit is again a complex one. It will be observed that we have divided it into two parts—in England and in Mexico. No firm ought to accept less profit on a foreign order than it would make on the same order delivered in this country; the contingent risks of disputes, bad debts, and delayed payments, will more than sweep away the advantage of the heavy amounts which shipping orders sometimes cover. But beyond this English profit, there should be added a profit on the freight and expenses abroad, and such other profit as a firm shipping to, or established in the country, would usually make. If our English engineers could only see the books of some German factors established in Central and South America, they would be astonished at, and envious of, the very prosperous character of these businesses.

It will be seen that these foreign contracts involve much more than engineering knowledge, or ordinary engineering estimating. Our readers would therefore do well to apply to themselves the warning we have already given of the danger of accepting the figures of an outside commercial expert on a business the ramifications of which he does not understand. An engineer can seldom be more of a commercial genius than an auditor or accountant can be an engineer. On these matters of freight, foreign expenses, and fluctuations of exchange, he should therefore consult the best mercantile advice he can procure. If he is wise, and has skilfully selected the whole of his staff, he will probably find no better adviser than the accountant or cost clerk of his own works, who should not only be trained by his official experience to deal with such questions, but whose interests should be loyally and indissolubly bound up with those of his employer.

# ENGINEERING COST ACCOUNTS.

## CHAPTER V.

### COST ACCOUNTS.

IMPORTANT as a true knowledge of the principles of estimating is to the mechanical or civil engineer, it will be seen that, with all the care and skill he can exercise, he can only make an approximation to the cost of the work to be undertaken. His success commercially will be in proportion to the approach to accuracy of these approximations, and he ought not, therefore, to neglect any aids to accuracy of which he can avail himself. We have already pointed out that great detail in the preparation of an estimate is desirable, both for drawing attention to the various stipulations of the specification, and for comparison of anticipations with accrued results. The former reason may probably apply more forcibly to civil engineering, complete mill furnishing, ship and large engine building, than to the smaller and less varying types of machine motors and tools, but the possibility of comparing results with anticipations is as desirable with these smaller contracts and sales as with larger ones. These comparisons, when the engineer takes the trouble to make them, will teach him, as probably nothing else can, where he has succeeded or failed in a purely commercial sense, and instruct him not merely in the aggregate profit or loss of his business, but in the actual contracts or machines, and the separate sections of those contracts or machines in which such profit or loss arises.

Taking the sum of his anticipations, an engineer may expect a profit of £1,000 on his coming six months' working; if at the end of six months he finds his profit only reaches £700, he naturally desires to know where the difference arises. An ordinary profit and loss account is of little service to him; he can compare his purchases and sales, his wages and salaries, his rates, taxes, and other management expenses, with those of former years, but the comparison is almost valueless. He finds that the percentage of management expenses was last year 15·71 per cent of the total expenditure, and this year it is only 14·93 per cent, the reduction in ratio being explained by an increase in wages paid. This increase is concurrent with a reduction of £300 in the profit he anticipated. How, and on what machine or contract, have the additional wages been expended? Has there been waste in labour on any portion of the work, or does the loss arise through breakdown in construction, through increase in rate of wages, through alterations in design during progress, or to some combination of these and other causes? These are the questions the engineer requires solved, and it will often occur that he can only obtain the solution through detailed cost accounts.

Nor is it for this purpose alone (the comparison of an estimate with the actual resultant cost) that these accounts are useful; they are most desirable, if not, indeed, imperatively necessary, for the preparation of future estimates; they are the most efficient aids he can obtain to accurate anticipations of the cost of any future contracts he may tender for. But in the preparation of these costs there must be no confusion of thought; they must be actual results, compiled from the wages sheets, stores issues, cash and other subsidiary books, so that their aggregate may equal the total expenditure which appears in the financial books of the firm. The practice, which some have adopted, of placing this work in charge of student or cost engineers has seldom proved satisfactory, since they have not received the accountancy training necessary for such work, nor have they sufficient access to the materials required for it, whilst ordinary bookkeepers and auditors are too often content with such figures as will elucidate their general balance-sheet and trading account, without regard to the more important needs of the engineer or contractor; at most they only furnish the employer with departmental trading accounts, which are certainly not cost accounts as he rightly understands them. Cost accounts should show in fully as much detail, and in many cases in more detail, than is employed in the estimates, the expenditure on the various portions of an order, summarised at the close into the total expenditure on such order. Estimated figures should only be admitted in them for temporary purposes, and should be corrected as soon as possible by substitution of actual figures; and the total of these costs should exactly agree with the trading account of the concern, so that the expenditure side of such account could be as accurately, though under different headings, prepared from them as from the financial books. The employer should not be asked to accept less than this, for with sufficient staff, and proper arrangement of the books and accounts, it can be given him; nor should he be content with less, for that which can be rendered him is no more than is necessary for the efficient conduct of his business. Some few engineering firms already prepare elaborate statistics of expenditure, and arrive at sufficient and accurate results; but as we are not writing for the few, but for engineering firms and managers who desire, and have not yet attained, such sufficiency and accuracy, we shall treat the subject very fully.

If we are to attain to this accurate agreement between the two forms of accounts, it is absolutely necessary that the same foundation should be used for each, and it is at least desirable that both should be controlled by the same official—that is, by a skilled and trusted bookkeeper or accountant. It is, however, needful for this accountant to recognise that he has two distinct, though parallel, operations to perform, and that his books must be so arranged as to produce the more detailed information required by the engineering manager, in addition to the summarised figures of the profit and loss account and balance-sheet. No doubt modifications in subsidiary books of account will be necessary, but the precious ledgers, journals, and cash books, on which accountants pin their faith, may be left practically untouched.

The principal charges against the firm arise in materials and wages, only a few additional items of expenses having to be added thereto from the invoice or cash books. We will take the first as being generally precedent in order of time. With most firms doing business to any great extent it is a practice to paste all invoices received for goods and charges, after careful correction and examination, into an invoice book, ruled on the right-hand side with cash columns for analysis, headed to correspond with those expenditure summaries which, at the close of the financial year, form the debit side of the trading account. One great advantage of this invoice book is that it largely dispenses with the troublesome and antiquated journal, and at the same time provides ready access to the invoices when consulting the analysis thereof. The form ordinarily used is as shown on opposite page.

The total of invoice so inserted is the amount of invoice rendered, assuming it to be correct in weight or quantity and price, the deduction for discount or other allowance being adjusted through the cash book. In cost accounts, however, it is most desirable—indeed, we may almost say imperative—to get rid of all such conflicting items as discounts and allowances before they get into the accounts at all; no after correction or adjustment will be so satisfactory. It is only necessary to remember that a large proportion of the goods covered by these invoices will pass into the storekeeper's charge, and by him be issued in small lots to various contracts, and at dates extending over a considerable period, to see that a correction which may be perfectly satisfactory in the financial books, will either involve an enormous amount of labour in the cost accounts, or more probably be altogether omitted, thus losing that perfect accuracy therein for which we must always be striving. When, therefore, the invoices are examined, after ascertaining that the goods have been received and are correct in quantity, quality, and price, a deduction should be made from the amount thereof of all trade and ordinary cash discounts, of any odd pence which will not be paid, and of charges of packages, &c., which will be returned. It is very easy for a bookkeeper to open a special package account (and that on the beloved and efficient double-entry system) for his financial books, without passing that account through the invoice book.

INVOICE BOOK.—JANUARY, 1895.

| Ledger folio. | | Total of invoice. | | | Iron. | | | Timber. | | | Sundry stores. | | | Rates, taxes, and insurance. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Space for pasting invoices. | | | | | | | | | | | | | | | |
| | Stockport Corporation ............ | 17 | 6 | 4 | | | | | | | | | | 17 | 6 | 4 |
| | James Adams .... | 167 | 3 | 9 | | | | 167 | 3 | 9 | | | | | | |
| | Henry Jones and Co. ............. | 365 | 14 | 2 | 310 | 16 | 0 | | | | 54 | 18 | 2 | | | |
| | Arthur Evans .... | 0 | 17 | 6 | | | | | | | 0 | 17 | 6 | | | |
| | Royal InsuranceCo. | 7 | 10 | 0 | | | | | | | | | | 7 | 10 | 0 |
| | Swiss Marine Insurance Co...... | 17 | 15 | 0 | | | | | | | | | | 17 | 15 | 0 |
| | Edward Ward .... | 63 | 9 | 7 | 50 | 10 | 0 | | | | 12 | 19 | 7 | | | |

But elimination is not all we require. We want another analysis to supply the necessary classification and particulars for the cost accounts, and to get this we must slightly modify the invoice book. And here let us remind our readers, that although in some works all material will of necessity pass through the stores, being purchased in greater quantities than are required for any single contract, in many large factories, and more especially in such as bridge-building works and shipyards, a proportion of the plates and angles will be ordered of specific dimensions, and for the purposes of a special contract. In the same manner donkey engines, pumps, forgings, and other fittings will be purchased specially for the contract on which they are to be employed, and for no other purpose. Whether such stores should be passed through the storekeeper's charge and books or not is a matter of yard bookkeeping and management, the solution of which will vary with the circumstances thereof. For the purpose of cost accounts it is probably more convenient to charge them direct through the invoice book, and we so treat them in the following example; but if the other method is, in any particular case, found more convenient, the same results may be obtained from the analysis of store issues, which we hereafter explain.

To meet our requirements we therefore add an additional column to the invoice book, and which we head "Process," so that it will read as under :—

| Total of invoice. | Date. | Names. | Process. | Iron. | Timber. | Sundry stores. | Rates, taxes and insurance. | &c. |
|---|---|---|---|---|---|---|---|---|
| £ s. d. | | | | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. |

We have still one further correction to make in this invoice book before it will present a correct record of the materials purchased, and charges admitted, during a given period. Whatever care is taken in examining the invoices before they are passed for record—and the greatest care cannot too strongly be insisted upon—many cases must arise in which goods are subsequently rejected and returned, and an allowance in price claimed and obtained. With some firms it is usual to pass these returns and allowances through the sales day book, but this method is open to the objection of improperly increasing the total of the sales, unless an adjustment is made by analysis of the day book and transfer entry in the ledger. The more convenient plan is to pass all credit notes received (or if they have not been received, notes made out by the bookkeeper for credits claimed) through the invoice book, making the entries for them, and the extension of the amounts therefor into both the total and allocation columns, in red ink, which ink in the invoice book should be used for the purpose of credit notes only. The totals at the foot of each page should be given separately for the black ink (debits to the firm), and red ink items (credits to the firm), and at the end of the period the red ink amounts should be deducted from the black. We shall thus arrive at the actual amount of purchases and charges, after all returns and allowances have been adjusted. There is another way by which the result may be obtained, and that is by keeping a credit book; but when we consider the very loose manner in which credit-book records are usually made, and the necessity there is for a correct "process" allocation, it will be seen that our method of passing them through the invoice book is the more convenient one. We are not teaching our readers bookkeeping, the art of which is given in many excellent primers, but merely explaining the essentials of cost accounts.

There must, however, in all engineering works be an enormous number of articles which are purchased for general use, and which for a time must remain in the possession of the storekeeper, to be used by him as occasion arises. Such stores as rivets, bolts, paint, oakum, bar and rod iron, are seldom, if ever, purchased for any particular contract, nor would any careful manager entrust to the riveters at one time all the rivets they require for a boiler. And here arises a great difficulty in the keeping of cost accounts. In all but the largest works, the storekeepers are only educated labourers or pensioned army sergeants, who seldom understand either the elements of bookkeeping or the business which is being carried on. Honest undoubtedly they as a rule are, but intelligence is required as well as honesty, and the cost accountant who aims at accuracy must not credit them with too much brain power. He must, on the contrary, exercise a constant supervision over the stores received book, the issue book, and stores ledger. The first-named must agree in quantities and prices with the invoices passed to the debit of the firm, and the total of it for the month must agree with the total of the financial or bookkeeping invoice book. The stores ledger should be kept in ordinary ledger form, under the headings of the various classes of goods, as ¾ in. rivets, ½ in. rivets, ⅜ in. rivets, &c., &c., and not under the names of firms. The ledger debits must be those of the stores received book, and no debit must appear in the ledger which has not passed through that book, nor must any differ therefrom. The ledger credits must in like manner be taken with the same exactitude from the stores issue book. This latter book is probably the one which in this department will require the most supervision, since the difficulty of keeping a correct record of issues during a busy portion of the day is under any system most difficult. The storekeeper, with recollections of military promptitude, is apt to discharge the duty more immediately before him, without sufficient regard to such a trifle as the record of the transaction. Much of this difficulty may be overcome by a system of demand notes, and the character of these will vary with the special conditions of the yard. The [illegible] book may, however, be more uniform in character, and the following form will probably be found the most convenient which can be adopted.

STORES ISSUE BOOK.

| Date. | To whom issued. | For what process. | Goods. | Quantity. | Price. | Amount. | Total issues per process | Name of process. |
|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |

The third column will give the process or department for use of which the stores are issued. By process, we mean the subdivisions of work as distinguished from the total contract. Thus, in a machine shop, instead of inserting "Machine No. 471," we should make the record thus:

19th January....John Jones....Shafting No. 471....Bar iron, &c., &c.

The first money column will show the cost of each particular item issued; the second the total issues to each process. As will be seen later, the objectionable heading "General expenses" will admit of many processes or subdivisions, under one or other of which the issues to a department will appropriately fall. It can, therefore, rarely happen that stores need be entered as issued to the blacksmiths or founders, the joinery or the fitting shop, instead of some service therein. If, however, such general issues have to be occasionally made, and the materials are then kept in charge of the foreman or a sub-storekeeper, some provision must be made, by such subsidiary books as may from time to time be necessary, for bringing them under the proper charge when they are used. It should be an absolute rule that no profit or loss shall be made in stores issues so far as prices are concerned. For instance, the cost of a ton of rivets is not merely the price at which they are invoiced, but, in addition, the railway or canal freight and the cartage to the yard. Of course, it is not always possible to allocate all the freights and cartages, and they have to be dealt with under management charges, but greater cost accuracy is secured whenever it is possible to add them in the stores ledger to the cost of the goods, and by that amount, and that amount only, to increase the issue price. The cost accountant will, however, require to frequently examine these stores books under such circumstances, to ensure neither more nor less being charged in the issues than the actual cost price.

An abstract of the second money column under the different process heads must be made each month or week end, and a summary thereof will agree with the total of the stores issue book for the same period.

Finally, we have the important question of wages to deal with; and although many other forms of wage book may commend themselves, the following will be found generally convenient:—

| Name. | Process. | Time. | | | | | | Total time. | Rate. | Wages per process. | | | Total wages per man. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | | | | | | | | |
| Sydney Webb | Shafting, No. 471 | 1 | 1 | 1 | | | | 3 | 6/- | 0 | 18 | 0 | | | |
| | Saddles, No. 471 | | | | ½ | 1 | | 1½ | 6/- | 0 | 9 | 0 | | | |
| | Capstans, No. 471 | | | | ½ | | 1 | 1½ | 6/- | 0 | 9 | 0 | 1 | 16 | 0 |

From these wage sheets a weekly or monthly abstract must be made by the timekeeper of the amounts chargeable against each process, in the same manner as the abstract of stores issued, and the total of it must agree with the total of the wages sheet for the same period.

# CHAPTER VI.

## DIVISION OF COST ACCOUNTS.

WE are now in a position to arrive at the greater portion of the figures required for our cost sheets. From the invoice book and abstract of stores issued we obtain the materials consumed, and from the wages sheets the cost of labour employed. But before proceeding further, let us clearly ascertain what information the proprietor or general manager really requires beyond what his financial books already supply. We think his requirements will be of a threefold nature, and that he will desire to be told his expenditure on—

A. The various departments, such as offices, mould loft, joiners, blacksmiths, fitters, labourers, &c.

B. The various sections of each contract, as, for instance, cylinders (high, intermediate, and low pressure), cylinder fittings, cylinder covering, pistons, connecting rods, crank shaft, &c., each section having its cost completed independently and in its own entirety.

C. The total cost of each separate contract.

A very tyro in accounts will see that all these conditions cannot be complied with in one return; that it will be necessary to compile a different statement to show the cost of the drawing-office, to that showing the cost of the three cylinders of engine No. 99, and that some method must be arranged by which the charges against the various sections of a contract can be gathered together into one total charge against the entire contract. What, however, is not at first sight so obvious, although a little reflection will show that it must be so, is that the establishment charges must disappear as distinct and separate items during this process. Managers, foremen, draughtsmen and clerks are employed, and steam power is used, for the purpose of facilitating the execution of work, and for no other; their cost is therefore a portion of the cost of such work, and should be charged against the various sections of it in strictly equitable proportion, if such proportion can be ascertained.

Probably many methods are in vogue to attempt these ends, some seeking them by misleading simplicity, others complicating the returns, and trying the reader's eyes, by endless perpendicular columns. We are, however, of opinion that the most satisfactory plan is to divide the accounts into three, corresponding to the three problems propounded. These three accounts will, however, form one really continuous series, and for convenience of reference we will term them A, B, and C, viz. :—

Form A for departmental accounts.
Form B for process accounts.
Form C for contract accounts.

It will be readily seen that the majority of charges will follow this sequence: iron issued to the smiths will pass into that department for labour on it; when transformed into a ship's davit, it will be transferred to its proper place in the process accounts; and, finally, when all the charges against the contract are being collected together, it will find its final resting-place under one of the headings in form C.

Having arrived at this more definite understanding of our requirements and methods, we will examine our invoice book a little more closely, and see what particulars are required therein in addition to those usually given. The invoice book is a particularly good basis for this examination, as it will in practice contain all the various titles of charges which we wish to arrive at, though not all the items, whereas the wages sheets and stores issue book usually embrace only a portion of them. The accountant should therefore look upon the invoice book as the foundation for the cost accounts which he is to open. The example *here given* will serve for a firm of engineers having works in

## INVOICE BOOK —DECEMBER, 1895

| Amount of invoice, net. | Date | Name. | Process. | Iron and steel. | Rivets. | Smiths iron. | Timber. | Coal. | Sundry stores. | Freight and cartage. | Rents, rates, and insurance. | Plant. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| £ s. d. | | | | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. |
| 27 10 0 | | Lloyd and Co. | Contract No. 52 (Tehuantepec) | | | | | | 27 10 0 | | | |
| 187 17 9 | | Dowlais Iron Co. | Boiler No. 47 | 187 17 9 | | | | | | | | |
| 150 0 0 | | Green and Jones Ltd. | Plant—Economisers | | | | | | | | | 150 0 0 |
| 67 0 0 | | Liversedge and Co. Ltd. | Stores Department | | | | | | 67 0 0 | | | |
| 867 0 0 | | Rolt and Co. | Timber Department | | | | 867 0 0 | | | | | |
| 53 6 6 | | Miller Bros. | Boiler No. 47 | | 53 6 6 | | | | | | | |
| 12 0 0 | | Sun Insurance Co. | Management | | | | | | | | 12 0 0 | |
| 53 10 0 | | Dowlais Iron Co. | Smiths' Department | | | 53 10 0 | | | | | | |
| 147 6 0 | | Dudley Colliery Co. | Management | | | | | 147 6 0 | | | | |
| 17 10 0 | | L. and N. W. Ry. Co. | Stores Department, £16 9 6<br>Boiler No. 47, 1 0 6 | | | | | | | 17 10 0 | | |
| 365 10 0 | | Consett Iron Co. | Boiler No. 47, 35 0 0<br>Contract No. 52 (Tehuantepec) 330 10 0 | 365 10 0 | | | | | | | | |
| 565 0 0 | | Knowles and Tinker. | Contract No. 52 (Tehuantepec) 67 15 0<br>Contract No. 53 (Puebla) 497 5 0 | 565 0 0 | | | | | | | | |
| 17 0 0 | | Maddox and Co. | Boiler No. 47 | | | | | | 17 0 0 | | | |
| 1 19 6 | r'd | *Liversedge and Co.* | *Stores Department* | | | | | | 1 19 6 | | | |
| 35 0 0 | | Duke of Brunswick (chief rent) | Management | | | | | | | | 35 0 0 | |

England, who also export and erect machinery abroad, and will therefore afford us most of the examples we require.

Taking these various items as they arise, a quantity of sundry goods has been purchased from Lloyd and Company, and shipped to Vera Cruz, for use on a contract which has been secured at Tehuantepec. For the purpose of the financial trading account they will be properly charged to "sundry stores," but this is a heading which has no intelligible meaning in our cost estimates. No work is going to be done on the stores; they are not taken under the storekeeper's charge; they have been shipped abroad, and cannot possibly be used for any of the home contracts; and we therefore charge them in our cost sheets to "Contract No. 52" direct. If there is a branch house in Mexico (which we assume for the present purpose there is), the final adjustment of the charge will arise through the branch cost sheets, as we shall explain later. For the present it is sufficient to note that purchases made for a specific contract abroad, and shipped to the partner or agent in charge of that contract, shall be charged direct to it.

The next purchase, from the Dowlais Iron Company, is for boiler plates and angles for a specific boiler on order, or under construction, No. 47 of the firm's contracts. Both plates and angles have been ordered from the draughtsman's specification, with the usual margin for spoilt plates and contingencies, and are adopted specially for this boiler, and, so far as present work in hand is concerned, for this boiler only. We therefore charge the iron to boiler No. 47. But the only cost sheet with such a heading will be a B sheet, and we have before said that our materials and wages will usually follow the sequence of our threefold division—that is, from A to B, and from B to C. A moment's consideration will also show that if the iron is debited to the boiler, without being placed in custody of any departmental foreman, it is very likely to be used for purposes which do not get properly represented in accounts. The cost accountant has *therefore to* consider to what department the material will be delivered (in this case it will be to the boiler-maker's shop), and then to charge that department with it, but for the specific contract for which it is purchased.

The next item will be transferred at once to the plant schedule, so that the necessary depreciation may be written off in future.

From the Liversedge Company Limited a quantity of sundry stores have been purchased, which will pass into the charge of the storekeeper, and we therefore charge them to him. As he issues them he will be credited through his stores issue book, and the several departments receiving them will be debited.

The timber department is usually a branch of the stores, and under charge of the storekeeper, being separated in the books chiefly for the facilitating of record and reference, and greater convenience in stockkeeping. The timber will therefore follow the same course as sundry stores, being debited to the stockkeeper, and transferred from him to the several departments as the issues arise.

The purchase of rivets from Miller and Co. will be dealt with in the same manner as the iron received from the Dowlais Iron Company, these rivets having been obtained for the specific contract on the calculations and descriptions of the draughtsman.

We have three items for management, namely, fire insurance of the works, coal for the boilers thereof, and chief rent. Although management appears a peculiar title for a departmental account (the title is not imperative, and any more convenient one may be used), it must be remembered that the "A" sheets contain what may be termed subsidiary departmental accounts, which disappear and are merged in the departmental accounts proper at each monthly adjustment. They are only used that we may the more conveniently arrive at the various sums to be debited for management expenses to the "tinkers and tailors and candlestick makers."

The London and North-Western Railway account is dealt with in the ordinary financial books as one item, being simply carried out into the column of freight and cartage, but an examination of the invoice reveals that, whilst the greater portion of it is for carriage of sundry stores, a part of it is for the rivets purchased from Miller and Co. Now, in costs we are not dealing with quoted or invoiced figures, but with actual cost of materials, however that cost may arise. Carriage is part of that cost, and must follow the materials to which it refers. We therefore in the process column charge stores with the larger portion of the account, and boiler No. 47 with the remainder, according to our finding on examination of the invoice. We have not, however, done with this freight yet. The portion charged to the boiler will readily be dealt with ; it is, in fact, under the cost accountant's own control, and he alone will be to blame if he blunders with it. But the storekeeper has to obtain credit for the freight, and he can only do so as he issues the goods. He must distribute it in his ledger over the various items it covers (he can obtain the exact particulars from the railway account), and the amount thus added to each account will determine the issue price. The plan may seem, and undoubtedly is, very troublesome at first, but an intelligent storekeeper will, with a little instruction, overcome the difficulty. In the meantime, and indeed always, the cost accountant must frequently examine the stores books, to assure himself that the receipts and issues are being dealt with therein on the same basis and in strict conformity to the plan of his own accounts.

The analysis of freight is sometimes so lengthy and involved as to complicate the process column of the ordinary invoice book. It will often be found more convenient to use a separate guard book for freight and cartage accounts, or, if this is not done, a separate book for analysis. The column marked "Name" in our example should be of sufficient width to admit of the invoices being folded and pasted in the book.

An item of £1 19s. 6d. for Liversedge and Co. is inserted, marked "red." This is to represent stores condemned and returned to them, and the entry throughout must be made in red ink, so that it may be deducted from the totals of the several columns as added up in black ink. Of course, the amount will be credited to the departmental cost sheet, in the same manner as the original invoice was debited to it.

# CHAPTER VII.

## DEPARTMENTAL ACCOUNTS.

We may proceed to an example of the first section of our cost accounts, and hope that its seeming complexity will not appal our readers. It will be sufficiently clear to the bookkeepers or accountants who have to compile it, if only they understand the elementary principles of their business, and can be rendered sufficiently serviceable to engineers by very little explanation and study. We have selected as the department under consideration the fitters in a general engineering establishment, but the "A" sheets for other departments, or in other engineering or contracting works or factories, will follow the same general lines.

The account is divided into debit and credit sides, and will be seen not to differ very widely in form from a departmental account. As it stands, however, at present before us, there is an essential difference between it and the departmental account ordinarily prepared, inasmuch as the debits balance the credits without the interposition of any profit or loss. We have previously explained that this is needful for the keeping of accurate cost accounts, and that departmental profits must not be permitted in them. We commence the debit side with the stock on hand at 1st

## SHEET A. FITTERS.

| Debits. | Quantities. | Materials and expenses. | Salaries and wages. | Trade debits. |
|---|---|---|---|---|
| | | £ s. d. | £ s. d. | £ s. d. |
| *Stock, January 1st, 1895.* | | | | |
| Brass bolts | | 6 1 2 | | |
| Tubes | | 19 0 0 | | |
| Work in progress—Engine No. 117 | | 2 1 4 | 13 6 2 | |
| Sheer leg | | 4 7 6 | 19 1 7 | |
| Milling mach. No. 319 | | 2 1 6 | 5 1 2 | |
| Lathe No. 321 | | 3 0 2 | 4 6 5 | |
| *Purchases.* | | | | |
| Lloyd & Lloyd—Tubes | | 19 10 0 | | |
| Lancaster & Co.—Packing | | 9 6 0 | | |
| Evan, Jones, & Co.—Brass castings | | 15 6 4 | | |
| G. Ware & Co.—Steel rods | | 17 3 6 | | |
| *Wages* | | | | |
| Process—Engine No. 117 | | | 36 10 3 | |
| Sheer legs | | | 41 5 4 | |
| Milling machine No. 319 | | | 3 1 6 | |
| Lathe No. 321 | | | 7 9 2 | |
| Low Mill Co., Engine repairs | | | 47 6 6 | |
| *Transfers from Departments—Process.* | | | | |
| Stores—Engine No. 117 | | 0 6 1 | | |
| Sheer legs | | 1 4 3 | | |
| Lathe No. 321 | | 0 2 4 | | |
| Low Mill Co. | | 7 10 0 | | |
| Blacksmiths—Milling machine No. 319 | | 0 14 7 | 0 10 0 | |
| *Transfers from Departments—Establishment Charges.* | | | | |
| Steam power | | 2 2 1 | 1 6 4 | |
| Drawing office | | | 0 17 6 | |
| Office | | | 3 18 9 | |
| Mangement | | | 8 4 7 | |
| Cartage | | 0 13 7 | 0 3 1 | |
| *Interest* | | 8 7 4 | | |
| *Depreciation* | | 13 6 2 | | |
| | | 132 3 11 | 192 8 4 | |

JANUARY, 1895. SHEET A.

| Credits. | Quantities. | Materials and expenses. | Salaries and wages. | Trade credits. |
|---|---|---|---|---|
| | | £ s. d. | £ s. d | £ s. d. |
| *Estimated Charges.* | | | | |
| Lloyd & Lloyd, estimated in December. | | 19 0 0 | | |
| *Transfers to Departments*.................. | | | | |
| *Transfers to B and C Sheets,* | | | | |
| Sheer legs .......................... | | 13 0 3 | 64 15 2 | |
| Low Mill Co., Engine repairs ........ | | 31 6 0 | 52 7 9 | |
| Engine No. 117 ...................... | | 8 18 11 | 53 14 5 | |
| *Stock, January 31st, 1895.* | | | | |
| Work in progress — Milling machine No. 319 | | 3 7 1 | 8 19 4 | |
| Lathe No. 321 .. | | 4 11 0 | 12 11 8 | |
| Steel tubes .......................... | | 19 10 0 | | |
| Steel rods .......................... | | 17 3 6 | | |
| Packing ............................ | | 9 6 0 | | |
| Brass and copper bolts .............. | | 6 1 2 | | |
| Goods in transit, &c. ................ | | | | |
| | | 132 3 11 | 192 8 4 | |

January, divided under its several headings. A corresponding entry, varied to meet the then conditions, will be found on the credit side of the account for the stock at 31st January. It will be seen that brass bolts and tubes on hand on the first of the month had no labour expended on them, and they appear only in the materials and expenses column, but the "Work in progress" comprises not only materials, but also the labour which had been applied to such materials, and therefore charges appear as brought forward for such work in both columns of materials and wages. For the present we may dis regard the last columns on each side the account, "Trade debits," and "Trade credits," but it will be admitted as essential for the success of our system that "Materials and expenses," which are charges arising outside the yard, should be kept distinct from "Wages and salaries," which are charges arising within the yard. This separation must invariably be made from the commencement of the accounts, and continued to the end.

We have, in this example, divided the stock into the several items in which it appears in the stock sheets of December, but in actual practice this is not absolutely necessary. The details will be found in the December sheets, and the totals thereof, in the two columns, are all that it is needful to insert in the January sheets. Sometimes, however, as in the case of opening a new book, or a new roll of sheets for the year, it may be desirable to adopt the more detailed method.

The next heading in our sheet is "Purchases," under which we place the several invoices for goods which have been supplied during the month and charged direct to the fitter's department. For his own convenience, and to facilitate reference, the accountant should insert the names of the vendors, short descriptions of the goods, and any other particulars which his experience may teach him will assist him in tracing the goods, either back to the makers, or forward to their destination, for some specific repair or contract. The amounts of these purchases must be obtained from the invoice book—that is, from the same source as that used by the financial bookkeeper (if a distinct official) and the auditor for their trading account and balance-sheet. The total of the purchases in the several cost sheets for the month must agree with the monthly invoice book total; it will be understood that we have an "A" cost sheet for the stores, the same as we have for any other department of the establishment. It is seldom any wages will appear against these purchases. In a few isolated cases cartage may arise on stores debited to a department, which stores may be for use on several contracts, and in such case it is necessary to carry the wages along with the stores until they are consumed.

The next heading, "Wages," will be obtained from the abstract of wages sheets, and the total of the wages for the month throughout the sheets must agree with the total of the abstract. A shrewd accountant will here, as with the purchases, note on the face of his "A" sheet any information or particulars which will assist him in reference, or facilitate him in the later allocation of the wages. Wages should be divided under the two sub-heads (we have only give one in the example) of process and repairs. The former will comprise all work done in the ordinary way of manufacture or trade, in the construction of new machinery or fittings for the works, or in the execution of such replacement repairs as will in the financial books be added to the value of existing machinery. The latter will comprise only such repairs to machinery and fittings, within the department itself, as are necessary for keeping them in ordinary working order, and will be divided over the work executed during the month in the same manner as other establishment charges. Wages for work done on machinery in another department, and solely on behalf of that other department, will be transferred to it, to be there in like manner distributed over the work for the month.

We now come to a portion of the sheet which will *demand the utmost* care on the part of the accountant or bookkeeper, and great and cordial assistance on the part of the technical officers. For although we believe the bookkeepers of our engineering establishments are usually extremely well versed in their duties, and have considerable acquaintance with the work executed therein, they cannot be expected to have that minute knowledge of it which the officers have who daily and hourly supervise and examine it. If, therefore, engineers desire accurate financial results presented to them, they must be prepared to assist the compilers of those results to such extent as they may require it. Nor will time thus employed be wasted, for the manager of the shops, fresh from the work, and with the actual progress thereof fixed in his mind, will have the progress of the cost thereof very clearly brought before him. Remembering, for instance, the condition of engine No. 117 at the commencement of the month and at the end thereof, he will observe that the work done upon it during that period, in the fitting shop alone, has in direct wages cost £36 10s. 3d., and that the cost of it, as far as that department only is concerned, including establishment (management and divisible) charges, is in materials £8 18s. 11d., and wages £53 14s. 5d. It is impossible to exaggerate the importance of such knowledge to the managing technical officers; we believe it to be so great as to outweigh any loss of time they may incur, or any disadvantage which may arise from the breach of that secrecy of account keeping which some firms unfortunately still affect.

The transfers from departments are divided into two subheads, "Process" and "Establishment charges," but the same general principles apply to the computation of both classes. We have seen that there is a sequence in the cost sheets leading from the departmental accounts to the completed contracts. We shall now, with a little consideration, find an analogous sequence in the case of the "A" or departmental accounts. The debits to management, offices, drawing-office, mould loft, carriage and cartage, "A" accounts, will nearly all arise as original entries in the invoice book, store issue book, wages and salaries sheets, or cash book. They will rarely be complicated by transfers from other departments, although they will usually be cleared and balanced by transfers to other departments. We therefore place them first in the order of our "A" sheets, and proceed to clear them by transfer entries to later sheets. In doing this it is absolutely necessary for the accountant to ascertain from the managers and heads of the various offices whether any work has been done for any special department or contract; if so, the actual cost thereof (but only the actual cost) must be transferred to that department or contract in terms of materials and wages. A question will frequently arise as to the expenses incurred in seeking or tendering for contracts which may possibly not be secured for many months, or which may possibly not be secured at all. Several considerations will arise in connection with such charges, and the subject has many complications, but it will be dealt with in a later section. Such charges, however, as special freights on iron for boiler A or specific moulds for engine B present no difficulties; they can go to the department first receiving the iron or the moulds, and from that department, in the usual course of the accounts, to the contracts for which they are used. Special services rendered by the engineers, draughtsmen, clerks, and others must be treated in similar manner. Then the balance of the establishment charges must be distributed over the several constructive departments in the ratio of their wages. A little practice will render the accountant an adept at this work; it is not nearly so difficult as it appears, and will be greatly facilitated by courteous manners and cordial intercourse with the other members of the staff.

It will readily be seen from our remarks that although the "establishment charges" portion of the transfers from departments comes second in the form of "A" sheets, it will usually have to be dealt with before the "process" portion of the transfers. The latter will be found comparatively easy to deal with: such as arise in the store sheets are really a transfer through that sheet of the issues which appear in the stores books, with the proportion of establishment charges added thereto. Such as arise in the constructive departments, though merely the replica of the amount to the credit of the original department, can generally only be arrived at after consultation with the foreman or leading man in charge. In all cases it must be clearly determined that the transfers represent the actual cost in materials and labour, plus the proportion of establishment charges.

So far as the debits for materials and wages are concerned, we have now effected on an actual and reliable basis that which cost clerks and cost engineers usually attempt empirically. But to render our final results complete and correct, it is necessary to bring in the charges for interest and depreciation, and such estimated liabilities as are already incurred but have not yet passed through the invoice book. The following form will supply the necessary allocation of interest and depreciation. Although this example is taken from a shipyard, it is applicable to any factory or works, the titles in the first column only having to be altered to suit the case.

The first cash column, "Land," will agree with the value of the land in the last annual balance-sheet of the business, and will, in most cases, remain unaltered by depreciation or addition until the next annual balance-sheet. Provided, therefore, that the land is separately valued, as it frequently is, in the balance-sheet, there is no difficulty in checking the total of this column, and the division of this total under any heads desirable must be in accordance with the valuation of the property on which the asset is based. The division will, however, not be so minute as that of buildings or plant, and will usually be confined to two or three items, such as yard, cottages, and pasture or garden ground. The two next columns, "Buildings" and "Plant," must be obtained

SUMMARY OF INTEREST AND DEPRECIATION, JANUARY, 1895.

| | Land. | Buildings. | Plant. | Stock. | Total. | | Interest. | Depreciation. |
|---|---|---|---|---|---|---|---|---|
| Offices | | | | | | | | |
| Stores | | | | | | | | |
| Mould loft | | | | | | | | |
| Shed No. 1 | | | | | | | | |
| Launchways | | | | | | | | |
| Shed No. 2 | | | | | | | | |
| Launchways | | | | | | | | |
| Shed No. 3 | | | | | | | | |
| Launchways | | | | | | | | |
| Iron foundry | | | | | | | | |
| Brass foundry | | | | | | | | |
| Smithy | | | | | | | | |
| Forge | | | | | | | | |
| Steam engine and boiler | | | | | | | | |
| Machine shop | | | | | | | | |
| Joinery shop | | | | | | | | |
| Boiler-makers' shed | | | | | | | | |
| Shipwrights | | | | | | | | |
| Steam tug Pennar | | | | | | | | |
| Work in progress, viz. | | | | | | | | |
| Balance of interest | | | | | | | | |
| | | | | | | | | |

from the plant sheets, a form of which we give hereafter. In this case, however, the amounts entered in the summary sheets are those at the close of the month previous to that for which the interest is computed, and not that contained in the stock-taking list of the last balance-sheet. The next column, "Stock," must be compiled from the several "A" sheets, being the stock on hand, including work in progress, for each particular department at the date in question. The total of these four charges against each department, or process, will represent the amount on which interest has to be calculated as a debit against it.

The column of "Interest" presents some very difficult problems, and the determination thereof which may be perfectly correct in one establishment, will be found inaccurate and misleading in another. The first point to settle is the total amount of interest for the month. Where the firm is a private partnership, without much fluctuation of capital, or the complication of an overdrawn bank account, there will be little difficulty; the interest allowed on the partner's capital, or at the usual rate estimated if the business is a sole one, will form the basis for the month's total. Where, however, charges for loans, discounting of bills, and bank commission and interest are incurred, the accountant will require to exercise considerable skill and caution in fixing the amount. He must remember that his object is to ascertain the interest due on the month's transactions, and on the month's transactions only, and must therefore carefully guard against interest on a three or six months' bill being charged against one month only, instead of being spread over the whole period for which it runs. There is difficulty in this, but it is not insuperable. Having determined the total interest for the month, it must be apportioned over the several items, in proportion to the amounts in the "Total" column; the average rate will, in England, probably range from 4 or 5 per cent upwards, according to the financial position of the firm.

*In joint-stock* companies there is one factor which may be utilised for determining the total interest for the month. The company issues, say, debentures, preference, and ordinary stock, and has so far been successful as to pay interest and dividends on each. Ordinary stock stands in much the same position to the company as the partner's capital does to the firm, and preference stock is analogous to the capital of a partner having a first claim on the profits. The debentures carry a fixed rate of interest, which must be paid before any divisible profit arises, and the amount of this must be the first portion of the total. The next portion thereof is the dividend secured on preference shares, also at a fixed rate per annum. The third is the dividend on the ordinary subscribed capital, which may be more or less than 5 per cent, and which on parallel lines with those on which auditors calculate private partner's interest, should be set apart before profit proper is reckoned. Now, this interest has to be yielded by the various departments into which the works are divided, and therefore forms part of the cost of the work they execute.

At the foot of the account we place a line "Balance of interest." Any excess of capital bearing interest, or any unused capital on which interest is generally calculated, is to be entered on this line, and the interest extended in the same manner as on "Mould loft" or "Shed No. 1." If there is any small credit from the bankers for money in their hands, it must be deducted from this item, and also from the total of the month's interest, when the calculation thereof is made. The "balance of interest" must be transferred to "management" charges, for distribution over the several departments. It really accrues from management arrangements, and should therefore appear on that sheet.

It will be observed that we make an entry for interest on work in progress, which has to be specified in detail. This is a charge which will require some little discrimination on the part of the accountant. It would be perfectly absurd, for instance, to calculate interest on the various portions of a dozen machines, or two or three cranes or boilers, which are in course of construction in the various shops of an engineer's yard, and being proceeded with as rapidly as labour can be placed on them. Our example is, however, taken from one of the more complex establishments, viz., a shipbuilding yard, and there is more reason in such a yard, under certain circumstances, to calculate interest on work in progress. It may frequently occur that the work necessary for earning an instalment on a ship is practically complete, but payment is delayed in consequence of the omission of some small detail. In one instance (and it is, unfortunately, only one of many), the third and fourth instalments of a ship were, with the exception of some very trifling and inexpensive work, qualified for in September; but, in consequence of these trifling omissions, less than half of each instalment was paid in October, and the balance not until the end of the following March. By that time another instalment was earned and certified for, but payment of this was not made until June. There is clearly an increase in cost of such work as this through financing, and this increased cost should appear in the cost accounts. The transfer, however, of the amount should be to the "C" sheets, and not to any department or section of the contract.

We readily admit that this question of interest is a difficult one, and we have recommended the elimination of it in estimates. There is much reason in the contention that interest is no part of the direct cost of work; that although it is a charge against the firm, it is a charge which should be met out of the profits, and not deemed cost to be paid before the calculation of such profits. But the accounts we have under consideration are for the use of practical men, and not for academicians, and practical men have, at least in Lancashire, become so accustomed to consider interest as earned anterior to profit, and as increasing cost, that it will be difficult to induce them to follow any other mode of reasoning. We have therefore endeavoured to suggest a method by which at least the correct amount of interest shall be added each month to the several charges for materials and wages. Even where it is determined to omit all consideration of interest in cost accounts (which omission should be entire, or not at all), we should recommend the accountant to prepare an interest sheet in the form we have given, so that he may ascertain, and be able to show his principal, the way in which it affects the various portions of the works, and the contracts under progress therein.

The last column in the form, "Depreciation," is merely a summary from the plant sheets, and is placed here for convenience of distribution to the various departmental or "A" sheets. We are quite sure our accountant readers must frequently have been puzzled by the mysterious disappearance of machines or fittings; even the lynx-eyed auditor often finds great difficulty in reconciling the machinery of one year with the machinery of the next, which is perhaps hardly to be wondered at, seeing that he is generally profoundly ignorant of the uses or names of the machines. The Joint-stock Companies Act, 1862, Table A (which in this respect is generally adopted by limited companies), provides that the directors shall cause true accounts to be kept "of the stock in trade of the company." This stock in trade is understood to include the fixed machinery and running gear, machine tools, loose plant, and hand tools, as well as the iron, steel, and innumerable stores in the storekeeper's possession. A stock book, however, as generally prepared, although it may suffice for legal requirements, is perfectly absurd as a guide to technical officers to the expenditure on and present value of their plant. The total value is made to agree with the balance-sheet, and even where specific values are affixed to each machine, or tool, and depreciation written off each, it is at the same percentage rate throughout. Balance-sheets are generally prepared, both for companies and private traders, so as to show the capital expenditure either at its cost price, or at its balance value at last stock-taking, depreciation being written off in both cases. The form adopted is something like the following :—

| | |
|---|---|
| By machinery and plant as per last balance sheet | £8,000 |
| Add— | |
| Additions during the twelve months as per invoice and day books | 500 |
| | £8,500 |
| Less— | |
| Depreciation at 5 per cent per annum on *£8,000* | 400 |
| | £8,100 |

## CHAPTER VIII.

### Depreciation, Loose Tools, &c.

There is undoubtedly great difficulty in any mere accountant dealing with depreciation, and this difficulty is intensified when he is an auditor, visiting the works in a perfunctory manner once in six or twelve months, and basing his estimates on such data as the books afford him. He can know nothing of increased or decreased running speed during the period, nor of the effect it had on the machines, or their bedding; he can have no conception of the increased value given to them by judicious alterations or repairs; and he cannot even appreciate (or very rarely so) the effect of mechanical progress and inventions on the economic lives of the machinery. There are instances when a machine becomes in a few months so far superseded by an improved one, that it is more economical to sell it for *scrap iron* than continue working it; but it requires an engineer to understand this: the mere accountant walks through the shop, and views the pretty-looking, well-kept machine, without understanding in the least that it is a white elephant to its owner.

The machinery and tools are in charge of the engineer (or engineers), and the books of record thereof should equally be under his control. The bookkeeper, accountant, or auditor who makes the entries should be, so far as these books are concerned, what some officials of the type are termed in the government service, "a writer," who reduces into clerkly language the ideas of the mechanician. It will then be possible to correctly estimate the value of each machine, its probable life, and increased value after undergoing thorough renewal repairs. Something of the kind is attempted in certain businesses by re-valuing the machinery at stock-taking, and writing off the difference as depreciation. This, however, is almost as unsatisfactory as the "percentage" system, as the valuer, especially when a member of the firm or an interested official, has a conscious or unconscious inclination to maintain his stock in the accounts at the highest possible figure. Without any suspicion of fraud, there may thus be inaccuracies of account, and dividends or partners' drawings may for a time be bolstered up, whilst the plant on which they depend is rapidly qualifying for the scrap heap. This question of depreciation is more important than it seems at first sight—more important even than the money value between a wise and unwise appreciation of it; for on it oftentimes depends the employer's approval or disapproval of the management. Errors in judgment, and blunders in purchases or discipline, may easily be covered by re-valuation of plant or stock, and the more so when the result of this re-valuation appears only in one or two items in the trading account and balance sheet.

This should not be. The temptation, as well as the ability, to mislead should be taken away alike from auditor, bookkeeper, and *engineer*, and the books should be so arranged that any over-valuation will be the result of culpable and intentional misrepresentation, and not of mere inadvertence or of casual optimism. It is with this view that we recommend a complete inventory of all the machinery, machine tools, and plant in the establishment, arranged under the heads of the several shops or departments in which they are situated, and transferred in the inventory as the machines are removed from one shop to the other. Even a transfer for a few months should be recorded, so that there may be no danger of losing trace of the machine in the records on the one hand, or, on the other, of twice entering and valuing it. The opposite form will be found to answer all the essential requirements we have laid down.

The book or sheet (a book is preferable) is ruled with upright cash columns for depreciation and value for each of the six or twelve months it covers. It will not be found difficult to get twelve months' ruling into a moderate-sized book, and at the end of that period, which should agree with the date of stock-taking, the schedule should be re-written, and compared with the machinery and machine tools actually on the premises. It will be observed that we commence with a cash column giving the value on the 1st January, or other commencing date for the year. The amounts inserted in this column must exactly correspond with the final column of the preceding list, "Value at 31st December," any variation in the value at stocktaking having been adjusted prior to that date by an entry in the depreciation column. The first asset on the list is the building wherein the machinery is contained. Its cost, or proportion of purchase price, if purchased, was £300 in January, 1885, and a competent expert then anticipated that it would last for 20 years, at the end of which period the old bricks would be worth £25. Of course it will be easily seen that this is not what will happen in actual practice, as a building which had run down to old brick value would be perfectly useless as a *fitting shop* for a year or two before that time. What will *actually occur* is that repairs from time to time will be

| DESCRIPTION. | VALUE. | JANUARY. | | FEBRUARY. | | MARCH. | | APRIL. | | MAY. | | JUNE. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan. 1st, 1895. | Depreciation | Value, 31st. | Depreciation | Value, 28th. | Depreciation | Value, 31st. | Depreciation | Value, 30th. | Depreciation | Value, 31st. | Depreciation | Value, 30th. |
| | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. |
| | Life, twenty years, from January, 1885. Cost £300, less old bricks £25. | | | | | | | | | | | | |
| Building of fitting shop .......... | 162 10 0 | 1 2 11 | 161 7 1 | 1 2 11 | 160 4 2 | 1 2 11 | 159 1 3 | 1 2 11 | 157 18 4 | 1 2 11 | 156 15 5 | 1 2 11 | 155 12 6 |
| | Life, twenty years, from January, 1888. Purchased at £ 00, less scrap £5. | | | | | | | | | | | | |
| 10 in. centre gap lathe, No. 1...... | 57 0 0 | 0 7 11 | 56 12 1 | 0 7 11 | 56 4 2 | 0 7 11 | 60 5 8 | 0 8 6 | 59 17 2 | 0 8 6 | 59 8 8 | 0 8 6 | 59 0 2 |
| | From fitter's cost sheet.... | | | | 4 10 0 | 0 0 7 | | | | | | | |
| | Life, twenty years, from January, 1888. Purchased at £145, less scrap £10. | | | | | | | | | | | | |
| Bradbury shearer and puncher ... | 81 0 0 | 0 11 3 | 80 8 9 | 0 11 3 | 79 17 6 | 0 11 3 | 79 6 3 | 0 11 3 | 78 15 0 | 0 11 3 | 90 1 11 | 0 13 1 | 89 8 10 |
| | From fitter's cost sheet.... | | | | | | | | 12 0 0 | 0 1 10 | | | |
| | Life, twenty years, from January, 1892. Purchased at £115, less scrap £10. | | | | | | | | | | | | |
| 10 in. centre plain lathe, No. 2..... | 84 0 0 | 0 8 9 | 83 11 3 | 0 8 9 | 83 2 6 | 0 8 9 | 82 13 9 | 0 8 9 | 82 5 0 | 0 8 9 | 81 16 3 | 8 9 | 81 7 6 |
| | Life, twenty years, from January, 1892. Purchased at £60, less scrap £5. | | | | | | | | | | | | |
| 5 in. centre Bradbury capstan lathe, No. 3 ........................ | 44 0 0 | 0 4 7 | 43 15 5 | 0 4 7 | 43 10 10 | 0 4 7 | 43 6 3 | 0 4 7 | 43 1 8 | 0 4 7 | 42 17 1 | 4 7 | 42 12 6 |
| | Life, twenty years, from January, 1892. Purchased at £60, less scrap £5. | | | | | | | | | | | | |
| 7 in. centre Bradbury capstan lathe, No. 4 ........................ | 60 0 0 | 0 6 3 | 59 13 9 | 0 6 3 | 59 7 6 | 0 6 3 | 59 1 3 | 0 6 3 | 58 15 0 | 0 6 3 | 58 8 9 | 6 3 | 58 2 6 |

done to the building, so as to extend its usefulness to the end of the anticipated period, and these repairs will be charged as they arise to trading account. At the termination of 20 years, however, we anticipate that it will either require extensive repairs, or re-construction, or must be pulled down and replaced by an entirely new building, and we must, therefore, provide for the loss within that period of the money we spent in purchasing or building it. After the building we enumerate the various machines, and also the shafting and other various appliances within it. A separate line should be taken for each machine, or set of shafting, &c., and the description should be sufficiently detailed to prevent any possibility of error in identity. As in the case of the building, we commence by bringing from the previous schedule the value of the machine on the 1st January—that is, the original cost reduced by the amount of depreciation which has been written off up to that date. We then enter the depreciation for the month, and the deduction thereof gives us the value at the close of the month. The fixing of this rate of depreciation is an important matter: it should always be done when the machine is first made or purchased, and it should be done by a thoroughly qualified and experienced technical officer, and not by any accountant, however qualified by academic degrees. The method to be pursued appears to us to be, after carefully considering the construction of the machine, and the possibility of future improvements which may impair its value, to fix an expectant life for it, during which period its cost must be wiped out. There will, however, remain some scrap value for it, and this, recorded as well as the life on the face of the plant sheet, must be deducted from the original cost: the balance divided by the number of years gives the annual depreciation. No departure from this rate must be permitted, except for additions as hereafter mentioned, without a full explanation of the reasons for the change being furnished to the proprietor or directors, and his or their express sanction being given to it. Ordinary repairs, which are necessary for keeping the machinery in working order, must not be transferred to the plant sheet: they are part of the working expenses of the concern, and in no way enhance the value of the plant. However, it will frequently happen that extensive repairs or alterations, which we may term renewal repairs, will be done to some particular machine, and these increase its value over the sum at which it previously stood in the books by at least their actual cost, sometimes by more. As a matter of sound financing, no profit should be made on such work when done by the firm's own employés. It must be borne in mind that the due proportion of management and establishment charges will be added to the bare wages paid and materials used. Here again the technical expert, and not the accountant, must be called in to determine the rate of depreciation under the altered circumstances. The process will be the same as in the first instance: the number of years the machine will work under the new conditions has to be assumed, and the annual rate adjusted, to extinguish the debit within that period. The mode of recording the process is exhibited in two of our examples, but, as we have already mentioned, the term of running years may in some instances be extended through the repairs executed, and when this is the case a note thereof must be made on the face of the sheet.

The utmost skill in anticipating the future will not, however, stay the progress of mechanical invention, and the engineer may find himself face to face with some new discovery or combination which will, in the near future, render some of his machinery useless to him in an economical sense. Such an experience is never a pleasant one; to both directors and their managers it is a trying ordeal, to which many men endeavour to blind themselves as long as possible. But this ostrich policy is foolish, and generally productive of disaster. The wise plan is the courageous one, and the danger is reduced to a minimum when it is boldly appreciated and dealt with. In such cases as we have referred to, the engineer should go through his machinery schedule, and write down the remaining life of all machines to that which he thinks will, under all the conditions, be available for them. Thus, to refer to our sample sheet, the Bradbury shearer and puncher is at the end of June, 1895, valued at £89 8s. 10d., and is estimated to last as a useful machine for another 12½ years. At this period, however, an improved shearer and puncher is invented, the advantages of which are so obvious that it will rapidly be adopted by all firms, and displace the present machines, which will become of scrap value only. The manager, taking all the circumstances into consideration, concludes that he cannot possibly use the one at present in his works longer than two years. At the end of that time all his competitors will be in possession of the improved labour-saving machine, and he must also provide one to keep pace with them. We have therefore to provide for the extinction of £89 8s. 10d. within two years. But how, in the accounts, is this sudden and extra depreciation to be dealt with? It is surely unfair to charge it either as cost of the work in hand at the time, or even to spread it over the work which may be executed during the coming two years. It is a part of the initial latent decay of the machine, and has been becoming actual depreciation, although unknown, during the past 7½ years. The new machine will cost £150, about the same price as the old one, and may be expected to work for an equal period, subject, of course, to the same possibility of being superseded. During the next two years the depreciation chargeable against work as cost should therefore be no more than at June, namely, 13s 1d. a month, and the balance, £73 14s. 10d., should be immediately charged, in one sum, to the profit and loss account. It is one of those general losses, such as bad debts, and destruction by fire or wreckage, which cannot properly be charged against the working of the firm as mere working, but must come out of the balance shown in a primary trading account, which is transferred to a profit and loss account for apportionment. A financial question arises here as to whether such losses as these should be written off the immediate year's profits, or carried by means of a suspense account over a term of years. Undoubtedly the safe way is to write off the amount at once, and in no case should it be carried forward further than the replacement of the old machine by a new one; but so many questions of credit, reserve fund, and general character of trade are involved, that it is difficult to lay down any absolute rule. We may, however, repeat that the courageous course is usually also the wise one.

The depreciation written off in the financial accounts (that is, the profit and loss account and balance sheet) of the firm must be the total of that written off in the various plant sheets during the year. The financial books will then truly represent depreciation—a thing they now usually fail to do.

Loose tools are most troublesome to deal with, and are affected much in their rate of waste by yard management. Similar sheets to the plant sheets should be used for them, but the descriptions should either be omitted or summarised, and such other alterations made in the form as the circumstances of the works may demand. Whenever it is possible, each departmental foreman should be made responsible for his own loose tools, but this is not always practicable, and in any case a very heavy rate of loss and depreciation must be expected and provided for.

There is one more entry which will sometimes appear on the debit side of the "A' sheet, although we have not shown it on our model form. It is for "estimated charges." In most manufacturing concerns it is usual at the end of each year to make debit entry for unpaid wages carried forward, and also for liabilities incurred, but not invoiced. It will usually be sufficient to deal with estimated wages in the cost sheets for the last month of the year. If it is deemed desirable to estimate them monthly, it may be done, crediting them the following month, the same as materials; but this is a troublesome method, and not always necessary. But although we are sure that any wages unpaid in January will be duly dealt with in February (the men will take care of that), the materials received in the yard stand on rather a different basis. It is always desirable that they should be ear-marked in the month in which they are received, and placed in charge of some responsible officer, who will be credited for them as stock on hand, for which stock he is responsible.

The accountant must be careful that all goods which appear in the invoice book, which have not yet been received and accepted by the storekeeper, are included in the stock as goods in transit, and that any rejected on account of defective quality, &c., but which are not returned, are also included in stock as goods rejected. On the other hand, he must be especially careful that no credit is taken for goods without a corresponding debit for them, either through the invoice book or this item of estimated charges. Most of these cases will arise in the general stores department, and a genial and intelligent storekeeper will prove an invaluable assistant to the accountant in dealing with them; but the latter must ever remember that the responsibility rests with himself, and that it is on his own vigilance he must chiefly rely.

When we take the credit side of the "A" cost account, the first item which meets us is "Estimated charges for tubes, delivered in December." If we refer to the debit side, we shall find these brought forward as stock in hand at £19, the amount which had been estimated as their cost, and which is now written back. Later we shall find that they have been invoiced by Messrs. Lloyd and Lloyd, and included under the head of "Purchases," at £19 10s. It would appear that nothing could be done with them in the shop during the month of January, for they still appear on hand on the 31st of the month.

"Transfers to departments" have already been dealt with on the debit side of the account.

Transfers to "B" and "C" sheets will require some consideration. If we refer to the debit side, we find the following charges against sheer legs:—

| | Materials and expenses. £ | s. | d. | | Salaries and wages. £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Work in progress from December | 4 | 7 | 6 | ...... | 19 | 1 | 7 |
| Wages | — | | | ...... | 41 | 5 | 4 |
| Stores | 1 | 4 | 3 | ...... | — | | |
| | £5 | 11 | 9 | | £60 | 6 | 11 |

To these amounts we have to add the proportion of divisible charges (transfers from departments, establishment charges, interest, and depreciation), calculated on the proportion thereof to the "Process" wages paid. This will bring up the cost of the sheer legs, which are completed so far as the fitters are concerned, to—Materials, &c., £13 0s. 3d.; wages, £64 15s. 2d.; and these amounts are transferred to a "B" or "C" sheet, as the case may require. The same process must be followed with the Low Mill Company's engine repairs, and with Engine No. 117.

In the stock carried forward the work in progress is arrived at in the same manner; thus, for the milling machine, we have the work in progress brought forward from December: Materials and expenses, £2 1s. 6d., and wages, £5 1s. 2d.; wages paid during the month, £3 1s. 6d., and transfers from blacksmiths, materials, 14s. 7d. and wages, 10s. When to these we add divisible charges, we arrive at the work in progress to be carried forward for the month, viz.: Materials, £3 7s. 1d.; wages, £8 19s. 4d.

The same process must be followed for lathe No. 321, which is still incomplete. Steel tubes, steel rods, packing, and brass and copper bolts have, however, neither been consumed nor had any labour expended on them, and we therefore carry them forward as stock in hand at the same amounts as they appear at on the debit side.

The divisions of work will usually be more fully given than we have shown in this sheet; indeed, for our system of "B" sheets it is absolutely necessary it should be more minutely divided, but our present example will serve to illustrate the principle of arriving at the money values. It will be seen that when the sheet is completed the two sides balance, without any profit or loss. The whole of the debits to the fitters' department have either been transferred to work executed and passed out of hand, or are carried forward as stock; and this, so far as the departmental account is concerned, is correct.

## CHAPTER IX.

### "B" AND "C" COST ACCOUNTS.

IN order to render our "A" accounts perfectly clear, we must deal with one more difficulty which may probably have presented itself to our readers, namely, the making of goods *en bloc*, for after-use in the factory, or for sale. Let us, for instance, consider an ordinary loom. The construction of the loom itself resolves itself into the putting together of numerous parts which have previously been made in the factory. It would obviously be impossible to apportion the time or material consumed to each identical wheel or shuttle in the loom; the labour involved would be enormous, and the result would be valueless for any practical purposes. And yet it is absolutely necessary that the engineer should have some means of testing the cost of construction of wheels and shuttles at various periods, the same as he has of testing completed machines year by year. And this can be done by dividing the products into series. Thus, the first thousand change wheels can be readily separated from the second thousand, and the foreman in charge of the shop can say how much material has been used for "change wheels 1,000," and how much for "change wheels 2,000," whilst the timekeeper can obtain the same information for labour from the men's tickets. In the same way, if brass bolts are being made and screwed, they can be divided into sections of 1,000 or 5,000, or less, as may be deemed desirable, and the cost of each section ascertained. The first 1,000 change wheels, at the end of a month, have cost so much in material and labour; but although 700 of them have been completed and taken into stores, 300 of them are still in the shop only partly finished, and waiting further labour on them. This will be the usual condition of work of this class; the men are continuously employed, but do not finish up work at the end of a week or month to meet the requirements of scholastic or scientific book-keeping. There are two methods of dealing with the problem. All the 1,000 wheels can be carried forward as stock in hand in that department, and transferred to the stores debit in the following month. Or the 700 can be debited to the stores, and the 300 incomplete wheels only carried forward as stock. The latter is the preferable course in most cases, because the completed ones will generally be sent into stock immediately they are finished, and may probably be in course of issue when in the former way they appear as stock in the making foreman's charge. But in order to follow this preferable course the accountant must consult the foreman in charge as to the amount of work done on the 300, and the probable labour required to complete them. The division of wages and materials between the 700 and 300 wheels will resolve itself into a proportion sum, and any discrepancy will automatically adjust itself the following month.

This is one example of the numerous cases which will arise in any general engineering works each month. We need hardly cite any further evidence to prove our contention that detailed cost sheets demand both constant, indeed daily, supervision on the part of the compiler, and the most cordial and intelligent co-operation between all the officers of the firm. By pursuing the method we have indicated, the most minute subdivisions may be arrived at. Not only may we ascertain the cost of a shuttle of a particular batch, but the work on that shuttle may appear under various heads of trade labour, or of parts. This is only a matter of yard arrangement, but here again we find it to be a matter which can be satisfactorily dealt with only after consideration of the adjustments and requirements of the particular yard; it is a case for the engineer to state what he wants, and for the accountant or bookkeeper to supply it.

There is one account which bookkeepers generally delight in, and which they term "general" or "sundry" expenses. Into this they can tumble all sorts of charges without troubling their brains with the dissection of them. General expenses are really a portion of management expenses, and as such are divisible over the work in the yard; but if we make the latter account into a general receptacle, we shall merely have altered the title without remedying the evil. Accounts should be opened, or sub-heads made in the management expenses sheet, for travelling expenses, postages, stationery, office expenses, &c., so that the proprietor may know how his money is being spent, and may, if possible, close some of the flood gates. It is also advisable to adopt some such division in the ordinary ledger, where at present a general or sundry expenditure account exists. Great and preventable waste may at times be concealed under such a title.

The departmental, or "A" sheets, form the basis of our future accounts. Through them should pass all our debits or credits, with the exception of a few special items; and to them we look not only for details of cost, but for reference to the original financial books through which those costs arise. There is, therefore, necessity for the exercise of great care in dealing with them, and for the most lucid explanations of the various items which pass through them.

But the "A" sheets only inaugurate the accounts. They do not complete them, and, as we have seen, are themselves closed by transfers to a further account or accounts. This brings us to the "B" sheets, wherein we collect from the various departments, month by month, their charges against any particular section of the contract. They should be so headed—that is, divided and enumerated—as to compare with the original estimate. By taking one, two, or three of these "B" sheets, and adding together their net debits, we should be in a position to see how any particular portion of that estimate has been exceeded or reduced in actual working. We say one, two, or three sheets, because it will frequently be found desirable to subdivide the work, when actually in progress, into a much larger number of items than are contained in the estimate. This will be sufficiently clear to civil and mechanical engineers and their staff, though it may be difficult of understanding by laymen who confound costs and estimates in one category, or seek in Lloyd's rules guidance to the actual—and not merely hypothetical—cost of building a ship. Perhaps our best example of the "B" sheets will be from one of the more complex structures, and we will assume it to be for the keel, stem, and sternpost of a composite (steel-framed and teak planked) steamship. Such a process sheet is shown in the accompanying form B.

The form, as in the previous "A" sheet, has debit and credit sides, a plan which will be found the most convenient throughout, although it may apparently involve some little waste of stationery. The first debit is from "Purchases." Assuming that the forgings have not been made in the works, but have been purchased from a Sheffield forge, worked true to templets, and ready for erection in place, there is no necessity for debiting them to any department. They are not articles likely to disappear from the yard, and only incidental work, such as erecting, and adjusting an occasional screw or rivet hole, has to be done on them. Great caution should, however, be exercised by the accountant

# SHEET B.

## KEEL, STEM, AND STERNPOST, COMPOSITE SHIP ACORN.

**DR.** **CR.**

| Date. | Departments. | Quantities. | Materials and expenses. | Salaries and wages. | Trade debits. | Date. | Particulars. | Quantities. | Materials and expenses. | Salaries and wages. | Trade credits. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1895.** | | | | | | 1895. | | | | | |
| **Jan.** | To **Purchases** .......... | | | | | | | | | | |
| | **Blacksmiths**........ | | | | | | | | | | |
| | **Angle-iron smiths** .. | | | | | Mar. | **By Stores for scrap steel** ........... | | | | |
| | **Shipwrights** ....... | | | | | | | | | | |
| **Feb.** | **Purchases** .......... | | | | | April | **Transfer of balance to C sheet, composite ship Acorn** | | | | |
| | **Shipwrights** ......... | | | | | | | | | | |
| | **Platers and riveters** | | | | | | | | | | |
| **Mar.** | **Shipwrights** ........ | | | | | | | | | | |
| | **Platers and riveters** | | | | | | | | | | |
| | **Fitters** ........... | | | | | | | | | | |
| | **Blacksmiths**......... | | | | | | | | | | |

in transferring purchases from the invoice book direct to "B" sheets. No small stores, which can be misappropriated or lost, nor articles which can be used for other work, should be so treated. All these should be placed in charge of the storekeeper, or particular foreman, and debited to the "A" sheet of that department. The transfers from the departments have been sufficiently explained in dealing with the "A" sheets. On the assumption we have made they will be merely incidental charges for alterations or adjustments, and of trifling amount. In February we meet with another item for purchases, this being a transfer direct from the invoice book for a second section of the forgings, purchased under the same conditions of finish, and also with further transfers from departments for trifling work done.

The column "Quantities" can only be satisfactorily dealt with in co-operation with the technical officers. It is quite true that weights of materials can be obtained from the invoice book and departmental accounts, and the correct transfer of these is the duty of the accountant; but weights and cubic contents are only a portion of the information which we desire this column to convey to us. Let us take the first instalment of this same composite ship. We find it to be payable when two-thirds of the frames and reverse frames are in place. It is little advantage to know that a certain weight of steel has been passed to the ship's debit, or even that a certain sum has been spent in wages, unless we can at the same time readily gauge the progress which has been made towards earning this first instalment. Again, the fifth payment is to be made when the whole inside of the bottom planking is worked (all the teak required for the ship must for some time previously have been on the premises), and half the outer thickness. What possible help can it be to the manager or proprietor, who is looking to this payment for relief from pressing liabilities, to learn that a certain number of cubic feet of teak, with a certain weight of bolts and nuts, and white lead and oakum, have been debited to this portion of the ship, of which a large

474788

proportion will probably be returned and re-credited, unless he can at the same time see how nearly he approaches to the haven of payment? The weights and cubic contents are undoubtedly essential, and are a necessary element of good bookkeeping ; but the engineer's approximation of the work done, expressed in such engineering terms as he may adopt, is even more essential. The first should not be neglected, but the second should be added as an additional note or explanation. And in this additional note the accountant will be merely what we have before expressed him—the "writer" to the engineer.

On the credit side we find a transfer to stores for scrap steel. Where scrap can be credited on a departmental or "A" sheet (and by exercising a little care and ingenuity this can generally be done), it is much better, but occasions sometimes arise where waste is made alongside the erected machine or ship, and it is impossible to say what particular trade should benefit by it. In such case there is no alternative but to credit it to a "process" of work, as in this sheet, or even in some instances to the entire contract. This should, however, be avoided as far as possible, because, although it gives the total cost of the entire contract correctly, it leaves inaccurate some of the details thereof, and it is accuracy of *detail* which we are seeking. If we can be content with the total cost of each particular contract, we may obtain it with much less trouble.

It will be observed that the "A" sheets are closed each month, the work in progress and the stores on hand being carried as a balance to the next month, whilst the work completed during the month is transferred to one or more of the "B" sheets. The latter, however, are not closed in the same manner. Each has to be kept open until the process—that is, the section or item of work represented by the particular "B" sheet—is completed, when the balance of that account is transferred to the general summary, or "C" sheet, of which, of course, there is only one for each contract.

*This* summary sheet will be the one chiefly used for future reference and comparison with the estimate long after the work has been completed. During the progress of the work, and whilst alterations, modifications, and actual management are under consideration, the earlier sheets will be frequently referred to, and, as must be seen, they are actually necessary for the preparation of the completed account. When, however, the contract has passed out of the works, nearly all references will be made to "C" accounts, and it is therefore necessary that great care should be exercised in their preparation. It is well, when first opening any "C" or contract account, to write on the debit side thereof the titles of the several parts into which it is proposed to divide the costs. These will be at least as numerous as, and generally more numerous than, the headings in the estimate. When an estimate heading is divided into several in the costs it will be found convenient to place these together, and connect them by a bracket. Space should be left at the foot for additional lines to be added. The form of the "C" account will be as given on page 103.

We have added a line for interest to the debit of the contract. This is for interest on overdue instalments, as already explained; it must also include interest on overdue or renewed bills, or for payments made in stock or shares which are not yet earning dividends.

On the credit side we enter the eight instalments by which the ship will be paid for. We also have a line "Add materials," which may seem a little perplexing, since the contract is made not for labour only, but for materials worked into the form of a ship by means of labour thereon. However, it sometimes occurs that a tender has to be made in the following manner, particularly if it is for a vessel for the British or a foreign Government:—

| | |
|---|---|
| For the hull and fittings complete of ship —— as described in the foregoing specification....... | £ |
| For the engines and machinery of the ship to be constructed by —— as described in the machinery specification ........................... | £ |

In such cases we include, for record and completeness of contract cost and payment, the payments of engine and machinery instalments under the head of materials, and balance this by an entry on the debit side (it will be in one item only) of the contract price thereof, also under the head of materials.

It will be seen from the very form of it that this account is only closed when the contract is finally completed, when all adjustments and allowances have been made, and after the last instalment has been placed in the coffers of the manufacturer. It may sometimes happen—indeed, in these large contracts it will frequently occur—that demands are made by the purchasers for allowances in respect of inferior materials or workmanship, or delay in completion over the stipulated time. Most of these defects or delays will arise through the fault of several departments, and not of one, and some of them may be mere pretences for extorting a reduction in price. It will therefore be difficult to charge the allowance agreed upon to any particular department or trade; it is a risk contingent on the acceptance of the entire contract, and must be charged against the whole cost in the "C" sheet. It will follow the item for interest.

These forms of account will furnish the engineering manager or proprietor with the information he desires, and, we believe, in the form most convenient for his purpose. If he fails to derive any benefit from it, the fault will assuredly rest with himself, and not with the accountant or the accounts. It is, however, possible for misleading or incorrect accounts to be prepared, not intentionally (for "costs" should never be permitted to usurp the place of perfect double-entry financial records), but through carelessness or neglect. It is therefore desirable that we should have some means of checking these special accounts, and we may easily do this by a monthly profit and loss, or trading account, which will also afford us the additional advantage of seeing the progress during that period of the business in

## SHEET C.

### COMPOSITE SHIP ACORN.

**DR.** **CR.**

| | Materials and expenses. | Salaries and wages. | Trade debits. | | Materials and expenses | Salaries and wages. | Trade debits. |
|---|---|---|---|---|---|---|---|
| To Drawings, laying off, and model.......... | | | | By First instalment.... | | | |
| Laying blocks....... | | | | Second instalment... | | | |
| Keel, stem, and stern-post............... | | | | Third instalment.... | | | |
| Frames.............. | | | | Fourth instalment.. | | | |
| Deck beams......... | | | | Fifth instalment.... | | | |
| Teak planking....... | | | | Sixth instalment.... | | | |
| Bulkheads........... | | | | Seventh instalment.. | | | |
| Laying deck......... | | | | Eighth and final instalment.......... | | | |
| Cabins and fittings... | | | | | | | |
| Chart and wheel house | | | | Add materials.......... | | | |
| Flying bridge......... | | | | | | | |
| Steering apparatus... | | | | | | | |
| Boats' davits......... | | | | | | | |
| Boats................ | | | | | | | |
| Electric lighting..... | | | | | | | |
| Painting ............ | | | | | | | |
| Anchors, chains, warps, &c ......... | | | | | | | |
| Interest............. | | | | | | | |
| Add materials......... | | | | | | | |
| To Balance, profit....... | | | | By Balance, loss........ | | | |

its entirety. It is not absolutely necessary to prepare this account; perfect accuracy may be obtained by careful work and complete calling back and ticking thereof, but in most instances the monthly profit and loss account will be found the most convenient course to adopt. The form given on page 105 will be all that is necessary for this purpose in an English house.

This account will be prepared chiefly from the ordinary bookkeeping records. When there is a cashier or bookkeeper independent of, or subordinate to, the cost accountant, it will be desirable for him to prepare the profit and loss account, that the check may be more perfect. The stock on the first of March will be the same as he carries forward in his account of the 28th of February, and must agree with the total stock of the cost sheets. Indeed, it may be an advantage to adopt the cost-sheet figures, as the only stock his own books will give him will be that in the storekeeper's hands. This he should certainly check monthly, so as to limit the time wherein an error may pass undetected. Notwithstanding the evidence recently given before the Lords' Committee on the Amendment of the Companies Acts, it would appear that some of the most vital portions of auditing must, in any large establishment, be performed by the proprietor or his trusted assistants during the progress of the year, and not be left to the close thereof. It is more important to stop blunders or misappropriations on the part of a storekeeper during the first four weeks thereof than to satisfy a jury of his guilt after long months. The purchases, salaries, wages, carriage, cartage, and sundry expenses are obtained from the invoice and cash books; but resort must be had to the cost sheets for the estimated charges. On the credit side of the accounts the sales and additions to plant will be obtained from the day book, it being observed that, so far as these monthly balance-sheets are concerned, profit is not added to the wages and materials expended. The estimated charges will be obtained from the cost sheets, and the stock also, as already explained. We find a balance profit (in some cases it may be a loss) in

## DUNCAN, JONES, AND CO., WESTMINSTER.

### Approximate Profit and Loss Account for the Month of March, 1895.

| Dr. |  |  | Cr. |  |  |
|---|---|---|---|---|---|
| To Stock, March 1st |  |  | By Sales |  |  |
| Purchases per invoice book |  |  | Additions to plant: |  |  |
| Salaries |  |  | Materials |  |  |
| Wages |  |  | Wages |  |  |
| Carriage and cartage |  |  | *Estimated charges, viz.:* |  |  |
| Sundry expenses |  |  | Work in progress on contract No. 17 |  |  |
| *Estimated charges, viz.:* |  |  | Ditto on contract No. 19 |  |  |
| Rents, rates, taxes, and insurance |  |  | Ditto on sundry repairs |  |  |
| Water and way leave |  |  | *Stock, March 31st, viz.:* |  |  |
| Interest, gross |  |  | In stores |  |  |
| Depreciation, gross |  |  | In blacksmiths' shop |  |  |
|  |  |  | In fitters' shop |  |  |
| Balance profit |  |  |  |  |  |

this account, and our readers will readily observe that this arises from completed work or contracts which have passed into the "C" sheets. We have already shown in the "C" forms the profit or loss arising on a particular contract.

Now, if we make a summary of the balances for the month of the various cost accounts, we shall find that we obtain exactly the same profit or loss as shown in the approximate profit and loss account. The value of the check depends, however, on the two accounts being prepared independently of each other, and this value will entirely disappear if the monthly approximation is merely a transfer of the figures of the summary, arranged under fresh heads. Such easy method will render the extra work entirely useless.

# CHAPTER X.

## COST ACCOUNTS FOR SMALL WORKS.

IT is quite as necessary to keep cost accounts in small engineering works as in large. Although there is greater ease of supervision by the proprietor in the small establishment, the competition with other firms is as intense as that under which the large one suffers, and the results of any miscalculation or blunder are generally more disastrous. But there is a difficulty in keeping such accounts through the limited staff which is employed, and the impossibility of imposing any more work upon the clerks. In such places we usually find that the costs show only the net cost of wages and materials, without any true adjustment of machinery and management charges, or any means of testing the correctness of the results by comparison with the ordinary books of account. Even in a small engineering shop, it is sound polity to elaborate the costs in the same manner as in a more ambitious, and if proper office arrangements are made the work will not be found nearly so costly nor complicated as may be feared. But for the benefit of those engineers who cannot arrange their offices so as to adopt in its entirety the system recommended, we would suggest the following modifications of it, which will at least enable correct costs to be arrived at for each completed article.

An invoice book should be kept in the form shown on page 67. This will give the total purchases each month, which purchases should be debited to either stores account, or to the contract for which they are specially ordered.

In lieu of the schedule of buildings and plant on page 87 and summary of depreciation on page 79, accounts should be opened in the nominal ledger for the various divisions of equipment, such as :—

Land and Buildings,
Engines,
Boilers,
Lathes,
Shearing and Punching Machines,
Shafting,
Belting,
Loose Tools.

A percentage, to be determined by the engineer, based on the average expectant life, must be written off each class for depreciation. Ordinary repairs, to replace wear and tear, must be debited to a repair or machinery maintenance account, which will, in the books of the firm, be a charge against the trading, or profit and loss account. Special repairs, such as shown on page 87, will be debited to the specific division of machinery to which they refer (in the instance quoted, to the lathe account), and will thus become an addition to the capital expended on equipment.

The stores issue book will require to be kept, if any costs are to be compiled at all; and it is certainly desirable to retain the stores ledger if it can possibly be compassed. It is a great check upon the storekeeper, and not only assists in detecting misappropriations of stores, but frequently prevents such frauds through fear of detection.

The whole of the management charges may be grouped into one sheet, and the total depreciation for the month, which will be one-twelfth of the amounts debited annually to the various plant accounts in the nominal ledger, together with interest in like manner, and motive power and cartage expenses, may be charged to this sheet. The total of it, less stock, will be cleared by transfer to the departmental sheets in proportion to the wages of each department.

The arrangement is not an ideal one, as the establishment charges are not distributed equitably between the departments. Depreciation, for instance, is shared among them in proportion to the wages paid, irrespective of the value of the machinery employed by each; and the same applies to interest, without regard to the distribution of capital. It is, however, a somewhat nearer approximation to correctness than the percentage method, and brings the departmental costs into closer connection with dates of expenditure, or incurring of liabilities. It also permits of the cost accounts being balanced with the commercial books of the firm, and allows of the sub-division of contracts into sections in particular cases where it is needful to know the exact cost of such sections. It is not, however, a desirable plan where such sub-divisions are numerous or minute; in works where these are needful it is better to employ the system originally recommended in its entirety.

The working of the accounts will be readily understood from the following examples, with the explanations already given in Chapters VII. and IX. It will be seen that the "B" sheets are not applicable to this method (being merged in the "C" sheet) and will not therefore be employed. Nor is it advisable to use the columns for trade debits and credits, They certainly demand additional clerical labour, the saving of which is the sole object of the attenuation.

SHEET "A." # MANAGEMENT EXPENSES. SHEET "A."

| DEBITS. | Materials and Expenses. | Salaries and Wages. | CREDITS. | Materials and Expenses. | Salaries and Wages. |
|---|---|---|---|---|---|
| Office Expenses: | | | Transfers to Departments: | | |
| Purchases | | | Moulders | | |
| Petty Cash Payments | | | Blacksmiths | | |
| Salaries: | | | Turners | | |
| Manager and Foremen | | | Fitters | | |
| General Office | | | tock carried forward | | |
| Drawing Office | | | | | |
| Storekeeper, &c. | | | | | |
| Motive Power | | | | | |
| Machinery Maintenance | | | | | |
| Travelling Expenses | | | | | |
| Carting Expenses | | | | | |
| Depreciation: | | | | | |
| Land and Buildings | | | | | |
| Engines | | | | | |
| Boilers | | | | | |
| Lathes, &c., &c., &c. | | | | | |
| | | | | | |

SHEET "A." **FITTERS.** SHEET "A."

| DEBITS. | Materials and Expenses | Salaries and Wages |  | CREDITS. | Materials and Expenses | Salaries and Wages. |
|---|---|---|---|---|---|---|
| To Stock brought forward .......... |  |  |  | Transfers to "C" Sheets, viz: |  |  |
| Transfer from Management Expenses. |  |  |  | Contract No. 15, completed ...... |  |  |
| Issues from Stores, viz.: |  |  |  | ,, No. 16, ,, ...... |  |  |
| Contract No. 15 .................. |  |  |  | Stock, viz.: |  |  |
| ,, No. 16 .................. |  |  |  | Contract No. 17, in progress ...... |  |  |
| ,, No. 17 .................. |  |  |  | Brass Bolts ..................... |  |  |
| Wages, viz.: |  |  |  | Tubes.......................... |  |  |
| Contract No. 15 .................. |  |  |  |  |  |  |
| ,, No. 16 .................. |  |  |  |  |  |  |
| ,, No. 17 .................. |  |  |  |  |  |  |

SHEET "C." CONTRACT No. 15. SHEET "C."

| | DEBITS. | Materials and Expenses. | Salaries and Wages. | | CREDITS. | Materials and Expenses. | Salaries and Wages. |
|---|---|---|---|---|---|---|---|
| Jan. | Transfer from Blacksmiths .......... | | | March | By Amount of Contract for ..... | | |
| | ,, ,, Turners ............. | | | | | | |
| | ,, ,, Fitters ............. | | | | | | |
| Feb. | ,, ,, Blacksmiths .......... | | | | | | |
| | ,, ,, Turners ............. | | | | | | |
| | ,, ,, Fitters ............. | | | | | | |
| March | ,, ,, Fitters ............. | | | | | | |

# CHAPTER XI.

## FOREIGN CONTRACTS, AND TRADE DEBITS AND CREDITS.

IN the first section of our work, when treating of estimates, we referred to foreign contracts. If it is important that a separate provision should be made in the estimate for work executed abroad, it is surely imperative that the cost of this work should, in some form or other available for scrutiny, come under the notice of the principal at home. There is undoubtedly a difficulty in accomplishing this, because the legal forms and requirements in many foreign countries—as for instance Spain and the Spanish American republics—do not admit of modification in account books to suit modern requirements. The revenue and stamp duties present an additional difficulty. In most of these countries the books of record must conform to a certain type, and must comprise ledger, journal, and cash book, balanced in accordance with an established custom or rule of the Supreme Court. These books must be inspected, approved, and stamped by the revenue officials before they are used, and in some places at all events, invoices have to be stamped, and duty paid thereon before they are issued. These regulations are intended to be effective, and inspectors, armed with Draconic authority, regularly visit the offices of merchants and traders to inspect their invoices and receipts, and take note of any insufficient stamping, so that penalties may be inflicted on both vendors and purchasers. The law is frequently evaded, and whilst properly stamped documents are presented to the inspector at his periodical visit, those which have insufficiently contributed to the revenue are carefully kept apart. The use of the invoice book would under such circumstances be impracticable, and even if the difficulty of stamp duties could be overcome, and a skeleton book were used in which to paste the invoices, the courts would not admit it as a substitute for the official diary or *journal which* every trader must keep. The better plan is to keep the invoices on some convenient files, and to enter them as received and passed in a register book ruled in the same form as that previously given for the invoice book. From this register an entry can be made into the official journal (the page thereof will be substituted for the posting folio), and the legal requirements will thus be complied with without sacrificing efficiency. A private mark should be made on each invoice as it is entered, but this must not be a progressive number or letter, which might enable the inspector to discover the removal of any portion of the documents. Whatever difficulties might arise in the adjustment of the cost accounts to the nominal accounts in the ledger would be details which a skilful accountant would from time to time in some suitable way overcome. His task will not be rendered easier by the regulation which compels each ledger to be balanced within itself, and thus forbids the use of a private ledger as ordinarily kept in England. The accountant, however, may avoid some of the annoyances of these regulations by using his cost sheets for the purpose of explaining his trading transactions, and reducing his nominal accounts in the ledger to the least possible number. He will thus balance his ledger, and mystify the native clerks and inspectors, whilst at the same time he will have in his own possession, and available only for the information of his principal and himself, the most complete record of the various results of the business.

Engineering firms having branches abroad are generally both contractors and merchants. Even when ostensibly contractors only, the sales of the stores they import are frequently of such an extent as to involve the merchant element. Most of their debits will arise through the home invoices, and these will in a manner be transfers from the cost sheets at home to the cost sheets abroad, because the home cost sheet "C" will be balanced by the invoice which opens the foreign cost sheet "A." The debits which arise in the importing country will chiefly be for labour, and so will pass through the wages sheet and analysis in the manner already explained. All the triple series of sheets A, B, C, must be kept in the same way as for the home business, and, wherever the legal and revenue regulations will admit, the ledger nominal accounts should be cleared by a transfer to the London office, which transfer will be explained by the detailed cost accounts. Care must be taken, however, that no reference is made to these accounts in the official books of record, or they may be impounded by the courts as part of the official documents, and this will lead to very grave and disastrous consequences.

Freight charges will probably involve considerable labour and care to adjust correctly. Not only are goods from England usually shipped in delightful confusion, looms for Puebla being mixed up with pumps for Zacatecas, and threshing machines for Mexico with ore crushers for San Luis Potosi, but the American railroad system appears to be worked with a view to increasing this confusion. Goods are loaded up as they come most readily to hand, without regard to the consignments to which they belong, or the steamer by which they arrived at the port. As each freight note has to be discharged separately by the consignee, some idea may be formed of the trouble and confusion which arises when the cargo per "Texan" becomes mixed with the cargo per "Mexican," and some odd packages from each are kept on the wharves at Vera Cruz until a third or fourth steamer discharges there. It is, indeed, almost imperative to keep a very elaborate freight adjustment book in such cases; but if this difficulty is fairly faced, and dealt with from the commencement of the transactions, it will be found manageable. American railroad accounts are fairly well kept in their own method, and the particulars given on their notes ensure identification of the goods.

For such a business at Puebla, the accompanying table will be an appropriate form of monthly profit and loss summary.

There are few items in it which need any special notice. It will be seen that the money is kept in dollars and cents, the coin of the country wherein the work is executed. This, of course, is a more convenient method than sterling, and it is likewise imperative for the legal portion of the accounts under the municipal laws of the republic. Horses and carts are placed as a special debit, because of the large number of them used on many contracts. Although in such countries the price for a horse is a low one, and the native carts and harness are not expensive, a high price has to be paid for those of European or United States manufacture, and the total cost will generally mount up to a considerable sum; it is just one of the items of expenditure which should be prominently brought before the home authorities. In administration expenses we divide European officers from Mexican officers and inspectors. It is well to place on record the difference in money cost between these two classes, but it must be remembered that this difference represents only a portion of the facts to be considered. It will generally occur that the highly-paid Englishman will accomplish so much more work than the native as not merely to compensate for the extra pay given him, but also to render that extra pay a considerable source of economy. It is difficult perhaps to render this intelligible in terms of work, but an engineer or contractor's agent abroad who desires his principal properly to understand his situation and difficulties, will find some method of showing the value to himself and his employers of his English assistants. A line is entered for reserve fund. This will not be always needed, but it is desirable to provide a reserve in the case of many foreign contracts against such contingencies as delays or failure in payments, claims for variations between work and specification, and breaches of legal technicalities. Such contingencies more frequently arise abroad than at home, and are more difficult to deal with, owing to the difference in the laws, and the indifferent acquaintance which Englishmen generally possess with any laws or customs except their own.

On the credit side of the account we need only refer to

## BATEMAN, DUNCAN,

**Dr.** APPROXIMATE PROFIT AND LOSS ACCOUNT

| | Dols. | Cents. | Dols. | Cents. |
|---|---|---|---|---|
| To Stock, January 1st | | | | |
| ,, *Wages:* | | | | |
| Process | | | | |
| Repairs | | | | |
| ,, Sea freight, railway carriage, &c. | | | | |
| ,, *Horses and Cartage at Works:* | | | | |
| Purchases | | | | |
| Expenses per cash book | | | | |
| Wages | | | | |
| ,, *Office:* | | | | |
| Purchases | | | | |
| Expenses per cash book | | | | |
| Wages | | | | |
| ,, *Purchases:* | | | | |
| Materials | | | | |
| Coal | | | | |
| Iron | | | | |
| Timber | | | | |
| Cement | | | | |
| Land and way-leaves | | | | |
| ,, *Administration Expenses:* | | | | |
| European officers | | | | |
| Mexican officers and inspectors | | | | |
| ,, *Estimated Charges:* | | | | |
| Rent, taxes, and duties | | | | |
| Interest, gross | | | | |
| Depreciation, gross | | | | |
| Machinery and stores at carriage | | | | |
| ,, Reserve fund | | | | |
| ,, Balance, profit | | | | |

## AND CO., PUEBLA.

FOR THE MONTH OF JANUARY, 1895. **CR.**

| | Dols. | Cents. | Dols. | Cents. |
|---|---|---|---|---|
| BY *Sales as per Journal:* | | | | |
| Materials .................................... | | | | |
| Horses .................................... | | | | |
| Machinery and plant ........................ | | | | |
| Work estimated, viz.: | | | | |
| .................................... | | | | |
| .................................... | | | | |
| ,, *Contract No. 17:* | | | | |
| 3rd instalment ............................ | | | | |
| *Less* previously estimated .................... | | | | |
| ,, *Additions to Plant* | | | | |
| Materials and English invoices................ | | | | |
| Wages .................................... | | | | |
| ,, *Estimated Charges:* | | | | |
| Rent, taxes, insurance, &c., proportion unexpired .............................. | | | | |
| Water and way-leaves, proportion unexpired.. | | | | |
| Machinery and stores at carriage.............. | | | | |
| ,, *Exchange:* | | | | |
| Gain during the month .................... | | | | |
| ,, *Charges Against.* | | | | |
| Resident partner ............................ | | | | |
| London office .............................. | | | | |
| ,, Stock, January 31st, viz.: ...................... | | | | |

the adjustment of exchange. The settlement and distinct recording of this item each month will alone repay fully the cost and trouble of preparing the monthly profit and loss account, since the variations in exchange have of late years become a most important factor in the success or disaster of a foreign shipping or contract business. The item will pass into the cost accounts through the management sheet, or through an "Exchange" A sheet.

Let us consider how the detail cost sheets will work in such a case, so as to afford the London house a complete survey of the work abroad, and also to give the resident partner sufficient control of any agents he may have at outside stations. Messrs. Bateman, Duncan, and Co. have a branch house at Puebla, at which one or other of the partners is always resident. They are also constructing some railway extensions at Zacatecas, and engaged in extensive mining operations at San Luis Potosi, both these latter stations being in charge of resident engineers. For convenience of exchange operations, and the resident partner may more effectually supervise the entire business, goods for the two latter places will be invoiced by the London house to the Puebla house, and consigned to the order of the latter at Vera Cruz. The Puebla house will re-invoice them to the debit of the engineer at San Luis Potosi or Zacatecas as the case may be, together with any charges which may have arisen thereon after being placed f.o.b. at Liverpool. There is no profit on this transaction to the Puebla house, which simply acts the part of storekeeper, but a transfer may very properly be made monthly of a proportion of the management charges. This, however, should be fixed after careful consideration of the time employod by the Puebla staff on the work of the other branches, and not calculated on the ratio of either the wages or materials, which in this instance would be misleading. A similar transfer, arrived at in like manner, but detailed for division afterwards among the three branches, would also be made from the London office to Puebla. Now, when the debit note for the goods reaches

San Luis Potosi, it will be entered in an invoice register in the manner already described, and thence pass to the debit of an "A" sheet—stores department or some constructive or working department, as the case may be. A continuation of the cost sheet routine will give us the actual cost of work at each of the three separate stations.

And now for the use of these sheets. It is neither troublesome nor expensive to copy them when once compiled; indeed, a native scribe might do the work if his intelligence could be trusted *not* to interpret the meaning of it. A complete copy of the cost sheets and approximate profit and loss account, mailed to London and Puebla each month, would place the partners in a far better position for appreciating the financial progress and condition than they can obtain by any system now generally in use. An abstract or summary might be compiled in place of the copies, but complete copies will be found more useful in the majority of cases, and not much more expensive.

Nor is this the only advantage which arises in the instance of a house having two or three branches under the supervision of one resident partner. In order that he may supervise, or imagine that he supervises, the expenditure of each of them, the ledger accounts for machinery, wages, purchases, and sundry expenses of the others are closed by a transfer to his own office; thus a debit from London to Puebla for mining machinery is sent on to San Luis Potosi, and, after masquerading in the ledger there for a few months, is re-transferred to Puebla, but differing in amount by the addition of wages, &c., and more frequently than not included in one general sum which clears the machinery account. Accountants and bookkeepers will readily perceive that this cumbersome procedure is very likely to involve or hide mistakes, whilst to the engineer it will be equally evident that he gets a mass of figures which are perfectly useless to him, and fails to obtain that which would afford him help and guidance. The copies of cost sheets sent monthly to Puebla would, however, furnish the resident partner there with all the information he requires, both as to expenditure, local purchases, and the balances of stores on hand and partly completed work; whilst they would obviate the need for the troublesome clearing entries of re-transfer to Puebla. In the case of San Luis Potosi, as in the case of Puebla, the entire ledger may be closed by one general transfer entry to the London office. This, a mere bookkeeping device, may not appear of so much importance to engineers as to their accountants, but it will really avoid many difficulties which under ordinary methods arise in Spanish-American countries, and admit of the keeping of a private ledger or record book which at the present time is so frequently found impracticable.

There is one portion of the expenses of a large engineering establishment which may very properly be considered in connection with foreign branches and for contracts, namely, the cost of procuring orders and seeking future contracts. It is a question full of difficulties, and one on which many differences of opinion may arise. So far as the financial profit and loss account is considered, on which the principal bases his drawings, or directors recommend dividends, it is clearly right that the whole of a year's expenditure should be charged against that year's receipts, and only under some very exceptional circumstance should any portion of the salaries or travelling expenses of one year be carried forward into the next. The case of cost accounts is, however, very different, as here we are endeavouring to ascertain what it costs to produce any article in a given establishment, and not seeking to determine the amount of profit available for appropriation. Where firms are manufacturing standard types of machinery, machine tools, or fittings, for sale in the general market from the stock, it is clear the cost of agents and travellers should be divided over the several constructive departments in exactly the same way as other management expenses. *The charges* for obtaining orders, whether by peripatetic *canvassers* or extensive advertisement, is surely as much cost of production as the salaries of bookkeepers, storekeepers, and overlookers employed to send the goods out. If it were not for the orders secured by the former expenditure, the latter would largely be unnecessary. Some difficulty arises when new forms of pumps, or rams, or other specialities are being introduced. The advertisements are so extensive, that the cost of them often exceeds the first year's sales. It is hardly just to charge such efforts for trade results which may extend into many future years against the management costs of the year in which they are incurred ; they rather resemble the formation expenses of a joint-stock company, which, in the financial accounts, are spread over a series of years. We think such "Extra-advertisement charges," whether they be for advertisements proper or for additional travellers, should be carried to a "B" sheet, termed "Additional advertisement expenses," or "New turbine advertisement expenses," and a note made thereon of the term of years over which it is intended the charge should be spread. This being determined, a due proportion of the cost will be each month transferred from the "B" sheet to management expenses until the whole is absorbed. The difficulty which presents itself in the case of foreign contracts is still greater. Expenses have to be incurred for preliminary surveys, for journeys out to the country, for attendance on the executive ministers and legislature of that country, and for propitiating obstructive critics. These expenses cannot properly be considered a portion of the cost of the work then under construction, to which they bear no possible relation, and the execution of which they do not in any degree affect. Nor when railway contractors, shipbuilders, or builders, at home are employing all their own energies, and the best energies of their respective staffs, in tendering for and securing fresh orders or contracts, is it right to charge their salaries against waning and expiring contracts. To do this would be to perpetuate the evils of the pernicious percentage system with a vengeance. They should be carefully extracted and transferred to "B" sheets, or sheets opened for the expectant contract under suitable headings. When the contract is secured, and the accounts are in proper working order, the amounts will in due course be transferred from the "B" to the "C" sheets; and in the meantime the principal will at least have the satisfaction of seeing how rapidly his money is being spent on what may prove a Quixotic enterprise. We have known an instance where many thousands of pounds were spent in horses and instruments, camp equipage, surveyors' salaries, and food in a South American survey extending over many months; and though the engineer in charge was a very able and upright man, and really a skilful accountant, it was impossible afterwards to analyse the cost thereof without the expenditure of an enormous amount of labour, and the result finally obtained was eminently unsatisfactory. This should not be. The principal has a right not only to know how much money he has spent on these preliminary canters when they are finished, but also to learn from time to time how such expenditure is progressing, and to have it arranged under sufficiently distributed heads. This will be secured by the method we suggest.

Let us now turn back to the form of "A" sheets with which we commence our cost accounts. It will be seen we have there columns for "Trade debits" and "Trade credits," the use of which we have not yet explained. So far as we have proceeded we insisted that the departmental accounts, and indeed the accounts throughout, should deal with actual figures of wages, purchases, and expenses only, and that estimated figures should not be admitted except for temporary purposes, and with a view of after correction. This method of working leaves us with a profit or loss on a contract, but shows neither profit nor loss on any department. It is, however, desirable, and indeed at times essential, that the working of a department should be gauged in terms of money, and this we effect by means of these columns of "Trade debits" and "Trade credits," far more accurately and usefully than the ordinary auditor does with his departmental accounts and array of assumed and divisible charges. The aggregate result will be the same as in the primary accounts (it will be seen that the additional columns are continued into the "B" and "C" sheets), but the distribution will be different, being arranged with the object of showing the profit or loss of each department, worked as an independent concern, and making such profit as it can both out of other departments and general orders or repairs. The stock will be the estimated value of materials on hand and work in progress as it appears in the third money column of the previous month's sheet. The purchases will be the actual cost thereof, and will agree in amount with the first money column. The "Transfers from departments" will agree in amount with the items in the third money column of the credit side of those several sheets, but it must be observed that in the case of the earlier departments, such as mould loft, office, stores, or engine power, the first and second money columns will agree with the last, as it would be absurd to expect those departments to make a profit as against the others in the yard. The wages, interest, depreciation, and estimated amounts will likewise be the same as in the first and second columns. Indeed, the variation on the debit side of the account will be very slight, and will not call for the exercise of any special skill on the part of the accountant; it is chiefly care which will be required. Coming to the credit side of the account, however, he will not only require to display some business ability, but again, as on many former occasions, to avail himself of the good offices of the technical officers. The transfers to other departments or to subsequent series of accounts will not merely be the sum of wages and materials expended plus establishment charges, but these with such further sum added for profit as could be obtained from an outside purchase. Thus, when the cathead davit for H.M.S. Acorn is completed, and ready for transfer to its proper "B" sheet, the point for consideration, so far as the trade credit is concerned, is not how much it has actually cost, but what would have been charged for the work had it been executed for an outside firm, or what would have been charged to ourselves by Tyne or Clyde shipbuilders, or by Mersey forgemen, and this amount, having been fixed after careful consideration (on this commercial and comparative basis only, without reference to the special circumstances of our own yard), is the one to be inserted. The same course must be adopted with each department and each sheet, until the contracts are finally reached in the "C" sheets. The profit there will probably be a small one, or a loss even may, in some cases, appear; but if the accountant takes the trouble to extract the departmental profits (or losses) along with the contract profit or loss, he will find the result to agree with the primary cost account. And now the engineering manager will have before him not merely the actual cost of work in the yard under minute sub-divisions, but the same costs graphically compared with the sums he would have to pay outside firms, or which he could obtain from others for the same work; whilst at the same time he would see which departments were profitable to him, and which, if any, required overhauling and improvement. For the purpose of departmental profit and loss accounts it is allowable to make a profit on work done in making or erecting new plant for the firm's own use, but for this purpose only. The soundest finance will assuredly be to reckon no profit in the official or financial books, but only actual cost of material, labour, and establishment charges, on work done for the firm's own use.

We need hardly add that for the successful working of this, or indeed any adequate, system of cost accounts, the most perfect confidence must be reposed in the cost accountant. Probably they will be most accurately and effectively kept by a man constantly on the spot, who is permitted access to, and freely informed of, the various anticipations and efforts which are indulged in, and not merely confined to the recording of bygone facts: a man who is trusted as fully as the auditor is, and not merely regarded as a machine. Where such an accountant, sufficiently skilful and reliable, cannot be obtained by a firm as a member of their own staff, the better plan will be to arrange with the auditor to write up the cost accounts monthly, but it is extremely problematical whether this addition to his usual duties will prove either economical or satisfactory. We have sufficiently indicated the difficulties of such a course, and only mention it as an alternative to the hopeless plan of "making bricks without straw," by withholding from the cost accountant some of the figures or private details of the business which are essential for the successful production of his results. At the same time the depreciation account should be produced to the auditor as a voucher imperatively binding upon him for the amount written off for depreciation, unless his investigations lead him to the detection of some error therein. It is also desirable to exhibit the cost sheets confidentially to the auditor (but not to his clerks for checking and ticking), as they may considerably assist him in the due discharge of his difficult and important duties.

# CHAPTER XII.

## RESERVE FUNDS.

ALTHOUGH we shall be deviating from the limits of our title by treating of "Reserve Funds," the question of depreciation will hardly be completed without some reference to the manner in which they are built up and treated in the financial books, and without some consideration of the various methods of their investment. The subject has unfortunately been complicated by the treatises which have been written upon it. The cast-iron rules formulated by professional advisers, and lay learners, fail to meet the great complexity of the varied conditions which arise in different businesses. This is one of the penalties we pay for dissociating commercial financing from commercial management and control, a dissociation which modern conditions appear to foster and increase. We shall escape some of these difficulties if we confine our investigation to engineering and kindred manufacturing works, and recognise that the procedure applicable to such works will be absurd when applied to banking or discounting concerns. We must at the onset see that the contingencies to be provided against are of a threefold nature, and demand separate provisions for meeting them, and distinct methods of accumulating and investing the funds. The provisions required are for—(1) equalisation of dividends, and reserve against general contingencies ; (2) depreciation of buildings ; (3) replacement of machinery.

It is evident that a reserve fund which had to provide for all these several purposes might be wholly inadequate to meet them when they arose, not so much from the error of calculation as from incompatability of demand. If the directors of limited companies in prosperous days set aside a sufficient sum annually to meet, if duly accumulated, the demands for new machinery and buildings as they arose, with a small provision for dividend purposes, and grouped these in one fund, and one set of investments, we may rest assured that the reserve would be considerably depleted during a time of depression before shareholders would accept any diminution of their dividends. The provision for machinery and buildings would be deferred until the return of more prosperous days; indeed, it is probable that under some circumstances the machinery would be run long after its economical limit of life was passed, because the money which should have been used to replace it had been dissipated in dividends.

The necessity for a reserve for equalising dividends arises from that inherent weakness of human nature which refuses to accept any diminution of happiness. If shareholders after receiving 10 per cent dividend in a prosperous year would be equally content with 3 or 4 per cent the following, when adverse market conditions, or strikes and labour troubles, were against them, directors would not be under any necessity for withholding any portion of the profits from distribution, beyond that needed to provide for actual depreciation. But, unfortunately, shareholders are not gifted with such contentment. In prosperous years they will applaud chairmen and directors, and eagerly accept the largest dividend warrants offered them; in bad ones they will criticise their trustees, and lay violent hands on any and every means of increasing the amount for distribution. It is well, therefore, to fix a maximum dividend, not by articles of association, nor by special resolution, which would have an absolutely inflexible force, but by mutual understanding and agreement at the general meeting, and when in any year the profits exceed the amount required to pay this dividend, to carry the excess forward, and add to it from time to time any similar balances. This accumulation should appear distinctly in the account books and balance-sheet as "reserve for equalisation of dividends and against general contingencies," or some similar title which will properly define its character, and the object to which it can be applied. It is not intended to meet any sudden or pressing emergency, nor for the replacement of machinery or other capital expenditure. It may, therefore, very reasonably be employed in the business itself, as working capital, when by such employment a higher rate of interest can be earned than by investment elsewhere. There must, however, be no error as to the calculation of this reserve. As in the case of dividends declared and paid, all depreciation, repairs, replacements, and other contingencies must be first written off or provided for, so this amount carried to reserve can only arise after such provision has been made: it does not obviate the necessity for honest and sound financing in these respects.

The question of bad debts here arises: fortunately they do not present the same difficulties in the case of a productive establishment as in a purely merchant or more speculative business. No doubt whatever can exist in the mind of any prudent man that every bad debt should be written off from the profits of the business immediately it arises, but instances must occasionally occur when a bad debt is made of such magnitude as to absorb the profits of the year, and leave an adverse balance. The directors and shareholders have to consider whether this adverse balance should be carried forward or taken out of the reserve fund, supposing one to exist. A skilled accountant, accustomed to dissect and consider money figures, will arrive at the same result, whichever method is adopted, but as only few shareholders or investors are members of the Chartered Institute, the proper course is to guard against any possibility of misapprehension. If there is an adverse balance carried forward, it is evident that the reserve fund or funds cannot exist intact. There is, however, a danger that they may be so regarded if they appear undiminished, whilst the year's loss carried forward to the next year's accounts, is by the ordinary shareholder entirely overlooked. The same reasoning applies to a loss in trading arising from other causes. Whatever the practice may be, or whatever sanction it may obtain, we feel sure members of the engineering profession will condemn the entry in a balance-sheet of a reserve for equalising dividends of £10,000 (brought intact from the previous account), whilst at the same time a loss on the year's trading of £500 is on the opposite side, carried forward as a burden on the next year's profits. They will agree with us that the reserve in this case is only £9,500, and should be so expressed on the face of the accounts.

We have said this first reserve fund is not intended to meet any sudden or pressing emergency, and some objection may possibly be taken to this expression. And yet we think it is perfectly correct. The fund is set aside to meet specific forms of danger or variation, not to assist or provoke the directors to drive the business at the highest possible pressure, or to the verge of business prudence. When it has this effect the reserve actually becomes a danger to the stability of the firm, instead of the safety it was intended to promote. Sudden and unforeseen emergencies will arise in the best managed firms, as a crisis will arise in the strongest and most prudently conducted money market, but these are not to be combated by a mere reserve fund; the very existence of the firm is for the moment at stake, and its whole resources must be employed to meet the drain.

The second reserve is for replacement of buildings. We have already dealt with the manner in which this fund must be calculated and built up, instalments being set aside month by month or year by year, in such ratio as will extinguish the expenditure on the buildings at a given calculated date, and so provide for their replacement. Unlike the reserve for equalising dividends, this fund must be set aside without regard to profits; indeed, it must not only be a preference charge on profits, but must appear as a debit to Trading account before any profits are *calculated or* dividend declared. In years where an actual loss has been made irrespective of any depreciation, the depreciation must still be written off, and taken from reserve fund No. 1, if the condition thereof admits, or, if there be not any available balance, then carried forward as a preference charge against any profits in the following year. In cases, however, which we hope may be the experience of the majority of our readers, where the depreciation is duly written off, and the cash placed aside in the bank to meet it, the amount separated must be invested in readily available securities outside the business. It is a fund for the provision, at a given time, of new buildings, and must not be employed for any other purpose. This distinct and separate investment is not merely a security that it will not be so wrongfully employed, but it assures the directors of the certainty of the new buildings when the time arrives for erecting them. The following entries in the balance-sheet will explain our meaning more fully.

| LIABILITIES. | £ | s. | d. | ASSETS. | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| To reserve fund No. 2, for replacement of buildings, invested as on other side .............. | 300 | 0 | 0 | By £317 of 2¾ per cent consols taken at cost price, and held as security for reserve fund No. 2 .... | 300 | 0 | 0 |
| ,, Reserve fund No. 2, carried forward, as on other side .............. | 13 | 10 | 0 | ,, Profit and loss account, preference charge against next year's profits in respect of reserve fund No. 2 ............ | 13 | 10 | 0 |
| | | | | ,, Profit and loss account, balance carried forward .................. | 17 | 6 | 8 |

The third reserve fund, that for machinery, will exactly follow the lines of No. 2. The annual amount of it will be determined, as we have already said, by the schedule of machinery, the form of which has already been given in the cost accounts, and this schedule will be compiled on the most accurate data available to the engineer as to the length of life of the several machines and fittings. But as machines usually become, from various causes, useless and demand replacement long before buildings, and as they vary much in the prospective dates at which they will wear out, it is desirable the machinery reserve should be invested in securities which, as well as being perfectly sound, can be readily converted into money. A mortgage for 10 or 15 years, with sufficient margin, will be a perfectly legitimate and wise security for a reserve for buildings, provided they are expected to last and be serviceable for that time; but it will not be a wise one for a No. 3 or machine reserve, when the machines will require renewing, not at the expiration of that interval, but at various times during its course. We know the recommendations we make in this respect are rather old-fashioned, and sacrifice high rate of interest in favour of security, but they are sound business, as business should be understood by the engineer who makes his profits out of his work, and not from his speculations.

We shall but ill have preached our sermon unless we have made it clear to our readers that it is on their own business experience, and technical knowledge and ability, they must rely for success. We can indicate general principles, and suggest rules and regulations, but as the captain of the "Cautious Clara" would remark, "the bearings of all these observations lays in the application of them." Without intelligent application no form of estimate, nor cost account, nor reserve fund will be of any service, and it is because we believe this intelligence will be forthcoming, that we so freely and trustfully submit our labour to the workers in our great engineering trades; to both professional engineers, and engineers' accountants, and draughtsmen.

THE END.

# INDEX.

PAGE.
Boilers and Engines should be separately estimated for ........ 43
Boiler Estimates ........ 1
Boilers, form of Estimate for ........ 4

Canvassing for future work ........ 120
Catalogue Machinery, form of Estimate for ........ 47
Consultations necessary between Officers and Staff ........ 6, 18
Contract Cost Accounts ........ 101
Contract Cost Accounts, form of ........ 103
Cost Accounts, division of, into three parts ........ 65
Cost Accounts, necessity for ........ 56
Cost Accounts for small works ........ 106
Cost Accounts to be actual results ........ 56
Cost Accounts, use in estimating ........ 2, 56
Credit Notes, mode of dealing with ........ 61

Departmental Accounts ........ 71
Departmental Accounts, details in ........ 74, 75, 76
Departmental Accounts, form of ........ 72, 73
Departmental Profit and Loss, mode of estimating ........ 122
Depreciation Account, form of ........ 79
Depreciation and Interest in Cost Accounts ........ 78
Depreciation to be determined by Engineer ........ 85
Depreciation, various causes of ........ 84, 89
Division of Cost Accounts into three parts ........ 65, 66
Drawings to be estimated for ........ 30
Duplicating to be avoided in estimating ........ 9

Engines and Boilers to be separately estimated for ........ 43
Establishment Charges, estimate of when yard short of work ........ 48
Establishment Charges to be calculated on wages ........ 10
Establishment Charges, percentage in estimates ........ 9, 11
Establishment Charges to be divided over work done in proportion to paid ........ 77
    Boilers ........ 1
    ision into Materials and Wages ........ 2

PAGE.
Estimates, details for comparison with Costs ........ 28
Estimates, forms for Boilers, Gas Engines, Steam Engines, Screw Steamer, Marines Engines ........ 4, 16, 26, 29, 42
Estimates, form of estimate for Catalogue Machinery ........ 47
Estimates, form of additions to Estimate for Foreign orders ........ 52

Foreign Contracts, provisions for ........ 112
Foreign Contracts, Profit and Loss Account for ........ 116, 117
Form of Accounts for Small Works ........ 109, 110, 111
Form of Additions to Estimate for Foreign orders ........ 52
Form of Approximate Profit and Loss Account ........ 105
Form of Contract Cost Sheet "C" ........ 103
Form of Departmental Cost Sheet "A" ........ 72, 73
Form of Estimate for Boilers ........ 4
Form of Estimate for Catalogue Machinery ........ 47
Form of Estimate for Gas Engines ........ 16
Form of Estimate for Marine Engines ........ 42
Form of Estimate for Steamship ........ 29
Form of Estimate for Steam Engines ........ 26
Form of Interest and Depreciation Account ........ 79
Form of Inventory of Plant ........ 87
Form of Sectional Cost Sheet "B" ........ 98
Form of Stores Issue Book ........ 63
Form of Wage Book ........ 64
Forms of Invoice Book ........ 59, 60, 67
Freights, &c., to be added to materials for Stores prices ........ 63, 64

Gas Engines, form of Estimate for ........ 16
General Expenses, Improper Account ........ 96
Goods Manufactured *en bloc* ........ 94
Goods purchased ready for use ........ 44
Government Specifications, details in ........ 35
Government Specifications, covering Clauses ........ 36

Interest Account, form of ........ 79
Interest, balance of ........ 81
Interest, determination of amount of ........ 80
Interest in Estimates ........ 12
Interest and Depreciation in Cost Accounts ........ 78
Inventory of Buildings and Plant, form of ........ 87
Inventory of Buildings and Plant, necessity for ........ 85
Invoice Book, amended form of ........ 60, 67
Invoice Book, form of ........ 59, 67

PAGE.
Labour, analysis of, by trades ... 17, 30
Labour Saving Machines, effect on cost and estimates ... 14
Loose Tools, depreciation of ... 91

Marine Engines, form of Estimate for ... 42
Materials, variations in price of ... 3
Monthly Profit and Loss Account ... 104

Patterns, estimating cost of ... 22
Profit, considerations which affect estimate of ... 13
Profit and Loss Account, form of ... 105
Profit and Loss Account, Monthly ... 104

Quantities to be estimated by Technical Officers ... 99

Reserve Funds ... 126
Reserve Funds, division of ... 129
Reserve Funds, investment of ... 130

Scrap, how Dealt with ... 100
Sectional Cost Accounts ... 97
Sectional Cost Accounts, form of ... 98
Small Works Cost Accounts ... 106
Small Works Cost Accounts, forms for ... 109, 110, 111
Special Services, charge in Cost Accounts ... 77
Standard Estimates for Standard type of Machine ... 17
Steam Engine, form of Estimate for marine ... 42
Steamship, form of Estimate for ... 29
Stock in charge of Departments carried forward ... 93
Stores, care to be taken not to duplicate in estimating...
Stores Books, examination necessary ... 70
Stores Issue Book, form of ... 63
Stores Ledger, method of keeping ... 62
Stores Ordered for Special Contracts ... 60
Sundry Expenses, improper Account ... 96
Surveys for future contracts ... 120

Time, record of, to be kept by foreman ... 8
Trade Debits and Credits ... 122

Unstable Equilibrium, market in state of ... 5

Wages, form of Book ... 64
Work in progress, Estimate of ... 98

---

*John Heywood*, Excelsior Printing and Bookbinding **Works, Manchester.**

Just Published. Crown 8vo, price 5s. net, post free.

**THE CHEMISTRY OF MATERIALS OF ENGINEERING.** By A. HUMBOLDT SEXTON, Professor of Metallurgy, Glasgow and West of Scotland Technical College.

Just Published. Price 1s. net post free.

**NOTES ON BOILER TESTING.** By FREDERICK GROVER, M.Inst.M.E., Assoc.M.Inst.C.E. Author of "A Practical Treatise on Modern Gas and Oil Engines," &c.

Crown 8vo, cloth, price 5s., post free anywhere.

**THE MANUFACTURE OF IRON AND STEEL TUBES.** By EDWARD C. R. MARKS, Assoc.M.Inst.C.E., M.I.Mech.E., Fellow of the Chartered Institute of Patent Agents.

Crown 8vo, cloth, price 2s. 6d. net, post free anywhere.

**THE NAVAL ENGINEER AND THE COMMAND OF THE SEA.** By FRANCIS G. BURTON, author of "Engineering Estimates and Cost Accounts," &c.

Second Edition. Crown 8vo, cloth, price 4s. 6d. net, post free anywhere.

**MODERN GAS AND OIL ENGINES.** Profusely illustrated. A full and exhaustive Treatment of the Design, Construction, and Working of Gas and Oil Engines up to date. By FREDERICK GROVER, Assoc.M.Inst.C.E.

Crown 8vo, cloth, price 6s. net, post free anywhere.

**THE APPLICATION OF GRAPHIC METHODS TO THE DESIGN OF STRUCTURES.** Profusely illustrated. A Treatment by Graphic Methods of the Forces and Principles necessary for consideration in the Design of Engineering Structures, Roofs, Bridges, Trusses, Framed Structures, Walls, Dams, Chimneys, and Masonry Structures. By W. W. F. PULLEN, Wh.Sc., A.M.Inst.C.E. M.I.Mech.E.

THE TECHNICAL PUBLISHING COMPANY LIMITED,
31, Whitworth Street, Manchester. JOHN HEYWOOD, 29 and 30, Shoe
Lane, London; Deansgate, Manchester; and all Booksellers.

THIRD EDITION.

## THE INDICATOR AND ITS DIAGRAMS: ENGINE AND BOILER TESTING.

By CHARLES DAY, Wh.Sc. The best book published for Practical Engineers and Technical Students. Price 4s. 6d. net.

SECOND EDITION.

## INJECTORS: THEORY, CONSTRUCTION, AND WORKING.

By W. W. F. PULLEN, Wh.Sc., Assoc.M.Inst. C.E., M.I Mech.E. Price 3s. 6d. net.

SECOND EDITION.

## PROBLEMS IN MACHINE DESIGN.

For the use of Engineers, Draughtsmen, and Students. By CHAS. H. INNES, M.A. Price 4s. 6d. net.

SECOND EDITION.

## CENTRIFUGAL PUMPS, TURBINES, & WATER MOTORS.

Specially adapted for Engineers. By CHAS. H. INNES, M.A. Price 3s. 6d. net.

Crown 8vo, cloth, price 7s. 6d. post free.

## THE MANAGEMENT OF SMALL ENGINEERING WORKSHOPS.

By ARTHUR H. BARKER, B.A. B.Sc., Wh.Sc., &c., author of "Graphical Calculus," "Graphic Methods of Engine Design," &c.

Crown 8vo, cloth, price 5s. net, post free anywhere.

## MARINE ENGINEERS: THEIR QUALIFICATIONS AND DUTIES.

With Notes on the Care and Management of Marine Engines, Boilers, Machinery, &c. By E. G. CONSTANTINE, Assoc.M.Inst.C.E., M.I.Mech.E.

THE TECHNICAL PUBLISHING COMPANY LIMITED,
31, Whitworth Street, Manchester. JOHN HEYWOOD, 29 and 30, Shoe *Lane, London*; Deansgate, Manchester; and all Booksellers.

AUG 18 1930